Treat Yourself or Promote Your Health: A Presentation and Examination of the Mechanisms Behind Health Behavior Spillover

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Dedication

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Abstract

Regular performance of multiple health behaviors additively benefits well-being (Loef & Walach, 2012). Little is known, however, about the psychological pathways by which the performance of one health behavior affects the subsequent performance of a second, different health behavior. A theoretical model was developed to examine six psychological constructs that might mediate this effect (i.e., self-efficacy, attitudes, identity strength, goal commitment, goal progress, and self-control resources) and was tested using exercise and eating behaviors. Study 1 tested whether a naturalistic exercise session led to changes in the psychological variables and whether these changes influenced a subsequent behavior – snack choice. There were substantial changes in all of the psychological variables from pre- to post-exercise, as predicted, but none affected snack choice. Study 2 investigated whether experimentally manipulating two categories of psychological pathways (i.e., those that were expected to facilitate healthy eating and those that were expected to lead to unhealthy eating) would influence the effect of exercise on eating behavior throughout the rest of the day. Although exercising did not directly affect eating behavior, it did indirectly affect three eating behavior outcomes, leading to increased fruit and vegetable consumption, decreased consumption of percentage of calories from sugar, and decreased indulgent food consumption. The effects of exercise on fruit and vegetable consumption were mediated by increases in self-efficacy, health goal commitment, and self-control resources. The effect of exercise on the percentage of calories consumed from sugar was mediated by increases in self-control resources. The effects of exercise on indulgent food consumption were mediated by increases in affective health attitudes and self-control resources, respectively. In sum,

the model proposed and tested here consolidates six different areas of research into explanations for the mechanisms through which behavioral spillover between two health-promoting behaviors might occur.

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The most common causes of death in the United States (e.g., cardiovascular disease, cancers) originate from a number of different sources and stem from some combination of the consistent performance of unhealthy behaviors (e.g., smoking, alcohol misuse) and failure to regularly perform health-promoting behaviors (e.g., physical activity, eating a healthy diet; McGinnis & Foege, 1993; Mokdad, Marks, Stroup, & Gerberding, 2004). In fact, at least 38% of deaths in the United States in both 1990 (McGinnis & Foege, 1993) and in 2000 (Mokdad et al., 2004) were attributed to the performance of unhealthy behaviors such as smoking, maintaining a poor diet, sedentary behavior, and alcohol misuse. More recently, the estimate of deaths that could be at least partially attributed to unhealthy behaviors in the U.S. has increased slightly to 40% in 2010 (Putzer & Jaramillo, 2015). Therefore, in order for individuals to achieve and maintain good health and to prevent premature death, a steady balance of multiple behaviors spanning a number of health domains is necessary.

To understand the factors behind health-behavior adoption and maintenance, health psychologists have created a large number of theories and models of health-behavior change that present the factors that contribute to both. Among the most popular of the theories are the health belief model (Rosenstock, 1974), the theories of reasoned action and planned behavior (Ajzen, 1985, 1991; Fishbein, 1967; Fishbein & Ajzen, 1975), social cognitive theory (Bandura, 1977), and the transtheoretical model (Prochaska & DiClemente, 1983). Although these and other theories are useful for understanding the conditions under which people will adopt or change their behavior,

they are limited in that they are designed to elucidate the precipitating factors behind enacting a *single* type of health behavior (Conner, McEachan, Lawton, & Gardner, 2016). In fact, the vast majority of research on health-behavior change focuses on one behavior at a time and whether people are able to maintain the performance of that particular behavior (Noar, Chabot, & Zimmerman, 2008). To illustrate, a 2000 supplementary issue of the journal *Health Psychology* included review papers on the maintenance of a single health behavior over time following a behavior change intervention for behaviors such as physical activity (Marcus et al., 2000), eating a healthy diet (Kumanyika et al., 2000), and smoking (Ockene et al., 2000). Furthermore, although taken together, health-behavior change theories have elucidated a large number of target psychological constructs, to date, there have been few tests of multiple targets at a time (Sheeran, Klein, & Rothman, 2017).

However, because multiple health behaviors contribute to overall health, it is important to understand whether people can adopt and maintain multiple behaviors at a time, and if so, it is also important to study the potentially multiple mechanisms by which performing one health-related behavior may affect the subsequent performance of a second, different health-related behavior. In recent years, there has been increased interest in multiple-health-behavior-change (MHBC) interventions, which are designed to change two or more health behaviors at a time (Prochaska, Spring, & Nigg, 2008). Despite the increased interest in and potential for MHBC interventions to have a more significant impact on people's health than would interventions targeting one behavior at a time (Prochaska et al., 2008), between January 2004 and December 2009, only 150 articles on multiple-health-behavior-change interventions were published (Prochaska &

Prochaska, 2011). In a different review of multiple-health-behavior-change interventions in adults between January 1990 and May 2013, only 220 studies were identified, with 110 of them published after 2010 (King et al., 2015). Additionally, the interventions identified in these reviews primarily focused on randomized controlled trials designed to change multiple behaviors concurrently and used changes in the behaviors as their primary outcomes. Most multiple-health-behavior-change interventions do not specifically examine the psychological relation between the changes in the multiple health behaviors they attempt to change, nor do they examine conceptually two separate occurrences of different health behaviors. Therefore, the purposes of this paper are threefold: 1) to highlight the importance of multiple health behaviors and the ways in which multiple health behaviors naturally co-occur, 2) to present a novel theoretical model that presents six pathways by which the performance of a single instance of one health behavior may affect the performance of a subsequent, different health behavior, and 3) to test this model using two studies that focus on how the performance of an exercise session will affect later eating behavior.

Recommendations for Health Behaviors

The government provides recommendations for how frequently each health behavior should be performed in order to optimize health. Some health-promoting behaviors, such as getting a vaccine or preventive screenings, only require periodic enactment (e.g., yearly mammograms; American Cancer Society, 2015). However, the performance of other health behaviors like moderate and vigorous physical activity (Centers for Disease Control and Prevention, 2011) and fruit and vegetable consumption (Krebs-Smith & Kantor, 2001) should be performed more regularly (i.e., daily or almost

daily). For unhealthy behaviors, alcohol should be consumed only in moderation (Dufour, 2001), and people should refrain from or quit smoking (National Center for Health Statistics, 1994). All of these recommendations should be followed regularly and consistently for maximum health benefits. In fact, it is thought that a large proportion of the more than 1.6 million deaths that occur each year from chronic diseases could be prevented if Americans adhered to the recommendations for the health behaviors that require regular enactment (Centers for Disease Control and Prevention, 2016).

Regularly performing multiple health behaviors has been shown to have cumulative health benefits, and it is most beneficial for people's health when multiple behaviors are changed concurrently (Fisher et al., 2011). In an initial demonstration of this phenomenon, data from the Alameda County Study suggested that the performance of health-promoting behaviors like regular exercise, healthy eating, and getting sufficient amounts of sleep were positively related to better health and that the effects were additive such that with each additional health-promoting behavior that was regularly performed, there was a corresponding increase in physical health (Belloc & Breslow, 1972). Recently, Loef and Walach (2012) conducted a systematic review and meta-analysis of 15 prospective studies that examined the relations among multiple health behaviors including smoking, diet, physical activity, alcohol consumption, and body mass index (BMI) and all-cause mortality. They found that people who performed four or more health behaviors had a 66% lower risk of all-cause mortality and that there was an inverse relationship between the number of health behaviors performed and risk of mortality. Taken together, these findings suggest that in order to maximize health, as many different health behaviors as possible should be consistently performed.

Clustering of Multiple Health Behaviors

When studying multiple health behaviors, it is first important to understand whether these behaviors naturalistically co-occur and if so, in what ways. If certain behaviors do tend to co-occur, then researchers can decide which behaviors may be most likely to influence one another and to determine which sets of behaviors would be ideal to study together. The field of epidemiology considers behaviors to "cluster" if the co-occurrence of different behaviors is greater than would be expected from the prevalence of the individual health behaviors (Schuit, van Loon, Tijhuis, & Ocké, 2002).

Evidence that multiple health behaviors do not form one cluster. A number of studies have taken a single factor approach and have examined whether many health behaviors co-occur to form a single "health-promoting lifestyle." This unidimensional approach suggests that someone who engages in one health-promoting (or unhealthy) behavior would behave in the same way towards all other health-promoting (unhealthy) behaviors (Patterson, Haines, & Popkin, 1994). For the most part, these attempts have been unsuccessful at identifying a singular dimension of health-related behavior (e.g., Langlie, 1979). Using factor analysis, Kronenfeld et al. (1988) were unable to identify a single factor that was formed by the health behaviors of alcohol consumption, smoking, stress management, diet, weight maintenance, and exercise. Different estimates suggest that only a minority of individuals (i.e., 10% for health-promoting behaviors, 2% for unhealthy behaviors) exhibit this unidimensional pattern (Patterson et al., 1994). More recently, data from the Third National Health and Nutrition Examination Survey (NHANES III) found that only 6% of all adults in the United States met all five recommendations for tobacco use, alcohol use, physical activity, fruit/vegetable

consumption, and dietary fat consumption (Berrigan, Dodd, Troiano, Krebs-Smith, & Barbash, 2003).

Evidence that certain health behaviors do cluster together. Although there does not appear to be adequate support for the unidimensional approach, other research suggests that certain health behaviors do cluster together. Although Langlie (1979) did not find support for a unidimensional cluster of health behaviors, she did find evidence for a bi-dimensional structure of preventive health behaviors – one that is characterized by direct risk behaviors (e.g., smoking) and one that is characterized by indirect risk behaviors (e.g., immunization behavior). However, most studies identify anywhere from three to seven clusters of health behaviors (e.g., Boone-Heinonen, Gordon-Larsen, & Adair, 2008; Patterson et al., 1994; Spengler, Mess, Mewes, Mensink, & Woll, 2012; Tapp & Goldenthal, 1982). These studies examine different health behaviors – ranging from exercise, nutrition, smoking, alcohol use, drug use, and road and water safety (Tapp & Goldenthal, 1982) to physical activity, dietary behavior, and media use (e.g., time spent watching TV or on the computer; Spengler et al., 2012) – making it difficult to compare the behavioral clusters across studies.

Furthermore, behaviors have been shown to cluster differently depending on the sample studied. For example, German adolescents who indicated that they engaged in high levels of physical activity reported average levels of media use and nutrition (Spengler et al., 2012), whereas in a nationally representative sample of U.S. adults, a high physical-activity level clustered with other health-promoting activities like a healthy diet and low levels of smoking and drinking (Patterson et al., 1994). This suggests that simply knowing whether people regularly perform a given health behavior may provide

little information about how regularly they perform other health behaviors. Instead, it may be more informative to examine how a single instance of a given health behavior can influence the performance of another health behavior.

In sum, it is clear that the routine performance of a variety of different health behaviors is necessary for improving overall health and that there are additive health benefits to doing each additional health behavior (e.g., Loef & Walach, 2012). Survey research suggests that although there does not appear to be a single factor "health-promoting" lifestyle (e.g., Langlie, 1979), certain health behaviors do cluster together (e.g., Boone-Heinon et al., 2008; Patterson et al., 1994; Spengler et al., 2012; Tapp & Goldenthal, 1982), although based on current research, it is difficult to compare these clusters across studies.

Overview of How Multiple Health Behaviors May Influence Each Other

Little is known about how the performance of one health behavior influences the later performance of a different health behavior. Studying the performance of multiple health behaviors in this way presents a unique situation because each of these behaviors can be performed sequentially, suggesting that the decisions to enact or to forego each behavior will typically occur within fairly quick temporal succession on any given day. Therefore, two health behaviors could influence each other physiologically (e.g., an individual becomes hungry after exercise and decides to eat more) or psychologically. Psychologically, the influence could either be affective (e.g., an individual feels healthier after exercise and based on that *feeling*, decides to make healthy eating decisions) or cognitive (e.g., an individual changes how they think about health behaviors after exercise and based on those *cognitions*, decides to make healthy eating decisions). The

focus here will be on the cognitive intrapsychic processes by which the performance of one health behavior influences the performance of a second health behavior.

Understanding the cognitive mechanisms by which performing or foregoing a given health behavior can affect the subsequent performance or non-performance of a different health behavior could have profound implications for health-behavior change theory, as well as for the design of interventions to promote health and prevent illness. Theoretically, this understanding would provide information about how current models of change could be expanded to include more than just one behavior and could narrow the temporal scope of behavior change theories to the isolated occurrence of two sequential health behaviors. Practically, if research can elucidate the ways in which performing one health behavior positively (or negatively) affects the performance of a different health behavior, these findings can be used to design interventions that target multiple health behaviors. If changing the ways that people think about one health behavior can affect downstream health behaviors, then these interventions would have the potential to positively affect multiple health behaviors. As previously established, many health behaviors need to be performed frequently and consistently in order to maximally benefits health (Loef & Walach, 2012), so understanding how to maximize the performance of multiple health behaviors could have implications for overall health.

Behavioral spillover. This idea that the performance of one behavior may affect the later performance of another behavior has been conceptualized as "behavioral spillover" and was initially developed within the pro-environmental-behavior literature. Behavioral spillover was originally defined such that changing one's attitude towards and/or performing a given pro-environmental behavior (e.g., recycling at home) would

have the potential to "spill over" into similar domains and become more general in a way that either facilitates the performance of other pro-environmental behaviors (e.g., taking public transportation) or promotes the performance of the same pro-environmental behavior in a different context (e.g., recycling at school; Frey, 1993; Maki, 2015; Thøgersen, 1999; Thøgersen & Ölander, 2003). This conceptualization of and previous research on behavioral spillover is important because it suggests that there may be some psychological connection between the individual performances of two different behaviors that serve to further the same overlying motive. For example, if someone has an overriding goal of being healthy, this implies that there should be a psychological relationship between the performance of two different health behaviors such as physical activity and eating behavior.

Patterns of behavioral spillover. Recently, Dolan and Galizzi (2015) reviewed evidence from different fields and research areas and found support for the idea that behavior spillover occurs in a variety of situations. They put forward a descriptive conceptual framework that elaborates on the three different patterns of behavioral spillover. Specifically, their focus was on the patterns of behavioral spillover that happen between two different, sequential behaviors that share some latent motive. The performance of the first behavior then either leads to the performance of a second behavior that is consistent with the present motive or to the performance of a second behavior that goes against the present motive.

Promotion spillover. The first type of spillover is called *promotion spillover*, via which the performance of behavior A serves to promote the performance of behavior B in the same direction (Dolan & Galizzi, 2015). Promotion spillover can work to either

encourage the performance of two different positive behaviors (e.g., physical activity and healthy eating) or to encourage the performance of two different negative behaviors (e.g., sedentary behavior and unhealthy eating). Examples of promotion spillovers include the cognitive dissonance effect (e.g., Bem, 1972; Festinger, 1957) via which one behavior is followed by a second, similar behavior in order to maintain cognitive consistency, and the foot-in-the-door effect (e.g., Freedman & Fraser, 1966) in which after people comply with a small request, they are more likely to comply with a larger request (Dolan & Galizzi, 2015).

Permitting spillover. In the proposed second and third types of spillover, the performance of the first behavior pushes the second behavior in the opposite direction, but they differ in the type of behavior that comes first. In *permitting spillover*, a positive behavior (e.g., physical activity) is performed first, promoting the performance of a subsequent negative behavior (e.g., unhealthy eating). Examples of permitting spillovers include *ego depletion* (Baumeister, Bratslavsky, Muraven, & Tice, 1998) in which performing one behavior reduces levels of self-control, which leads to reduced performance on a second self-control task and *moral self-licensing* in which after performing a moral behavior, people then perform a subsequent behavior that actually goes against these moral principles (Monin & Miller, 2001).

Purging spillover. Conversely, in *purging spillover*, a negative behavior (e.g., sedentary behavior) is performed first, promoting the performance of a subsequent positive behavior (e.g., healthy eating; Dolan & Galizzi, 2015). An example of a purging spillover is the *moral cleansing effect* in which performing one unethical behavior is

followed by a different behavior done to restore the person's moral integrity (e.g., Zhong & Liljenquist, 2006)

Summary of behavioral spillover. Taken together, this framework implies that performing one behavior has the potential to influence subsequent behaviors and that changing the way that people think about and perceive the performance of the first behavior may affect the type of spillover that occurs. Dolan and Galizzi (2015) argue that both researchers and policy makers should be cognizant of these types of spillover when designing interventions aimed at just one behavior because the intervention may ultimately affect other behaviors.

Exercise as a gateway behavior. Applying the concept of behavioral spillover to multiple-health-behavior change, the performance of one health behavior (e.g., exercise) may similarly have the potential to "spillover" and to subsequently encourage the performance of other health behaviors (e.g., healthy eating). To date, there is limited research on behavioral spillover between the performances of two different health behaviors. However, within the realm of multiple-health-behavior-change interventions, there has been a sizeable attempt to examine behavior spillover *over time* using what is called the "exercise as a gateway behavior" hypothesis. Consistent with the concept of promotion spillover (Dolan & Galizzi, 2015), several researchers have posited that exercise in particular may serve as a behavior that, when adopted, will spill over and promote the performance of other positive health behaviors (Blakely, Dunnagan, Haynes, Moore, & Pelican, 2004; Nigg et al., 1999; Tucker & Reicks, 2002). The rationale behind this hypothesis is that as people begin to exercise more, they recognize the health benefits

associated with being physically active and attempt to maximize those benefits by adopting other health behaviors (Tucker & Reicks, 2002).

Much of the research examining whether exercise serves as a gateway behavior that facilitates the adoption of other health behaviors has been done using the transtheoretical model (Prochaska & DiClemente, 1983; Prochaska & Velicer, 1997). This model divides behavior-change into stages in which individuals move from not even considering engaging in a behavior (i.e., pre-contemplation) to regularly engaging in it (i.e., maintenance). Cross-sectional evidence suggests that individuals who are farther along in these stages for exercise (i.e., they consistently exercise) are more likely to engage in other health-promoting behaviors (Blakely et al., 2004; Costakis, Dunnagan, & Hayes, 1999; Dutton, Napolitano, Whiteley, & Marcus, 2008; Emmons, Shadel, Linnan, Marcus, & Abrams, 1999). However, support for this hypothesis was mixed or unfounded in other studies, indicating that this particular type of promotion spillover may not always occur. For example, participating in an exercise intervention led to improvements on some dietary measures, but not on others (Wilcox, King, Castro, & Bortz, 2000), and in a cross-sectional survey, individuals who were in a more advanced stage of change for exercise consumed sufficient amounts of fruit and dairy products, but did not meet recommendations for vegetable and fat consumption (Tucker & Reicks, 2002). Taken together, there is mixed support for the "exercise as a gateway behavior hypothesis", suggesting that regular exercise may lead to promotion spillover by affecting changes in some, although not all, health-promoting behaviors.

Researchers have provided some hypotheses as to why exercise may serve as a gateway behavior. For one, people might want to maximize the initial health benefits

from exercise by doing other health-promoting behaviors (Tucker & Reicks, 2002). Another potential explanation is that participating in a clinical trial leads to a greater awareness of broad health issues (Wilcox et al., 2000), which subsequently leads to improvements in other health behaviors. However, these hypotheses do not appear to be exhaustive, and no one has yet explicitly tested these specific explanations.

Cross-behavior cognitions. These explanations for the exercise-as-a-gateway behavior hypothesis predict that the way that people think about an initial health behavior may have downstream consequences and influence other behaviors over time. Relatedly, two lines of research have examined cross-behavior cognitions, which are defined as the cognitions and beliefs that people hold regarding the interaction between two or more behaviors (Fleig, Küper, Lippke, Schwarzer, & Wiedemann, 2015).

The first line of research on transfer cognitions provides a plausible explanation for how promotion spillover (Dolan & Galizzi, 2015) occurs: Performing one behavior will promote the performance of a second related behavior through the use of similar cognitions and strategies. The second line of research on compensatory health beliefs describes how purging spillover (Dolan & Galizzi, 2015) may occur. This research recognizes that after completing an unhealthy behavior, people sometimes make (and follow through with) plans to complete a healthy behavior in order to compensate for the initial unhealthy behavior. Although to date, compensatory health beliefs have only been applied in this way to purging spillovers, it is also possible that they can be applied to understanding permitting spillovers (Dolan & Galizzi, 2015) in that people might believe that completing a healthy behavior is sufficient to compensate for later engaging in an

unhealthy behavior (i.e., they can engage in self-licensing; de Witt Huberts, Evers, & de Ridder, 2012).

Transfer cognitions. Broadly, transfer is the idea that people use the cognitions and strategies that they have used in one domain and apply them to support the increase of a similar behavior in a different domain (Barnett & Ceci, 2002). Transfer can occur in two ways: Either the changes in two different behaviors occur at the same time (i.e., transfer as co-occurrence), or the change in one behavior leads to eventual changes in the second behavior, similar to what the exercise-as-a-gateway hypothesis predicts (i.e., transfer as carry-over; Fleig, Lippke, Pomp, & Schwarzer, 2011). The concept of transfer has been used as an explanation for why similar health behaviors like physical activity and healthy eating may cluster together in observational studies (Lippke, Nigg, & Maddock, 2012) and for why people who plan their physical activity sessions are also more likely to make plans about their fruit and vegetable intake (Fleig et al., 2015). More specifically, transfer cognitions are the thoughts that people hold about how regularly engaging in one health behavior will influence the enactment of another health behavior through the use of similar self-regulatory strategies (e.g., planning; Fleig, Kerschreiter, Schwarzer, Pomp & Lippke, 2014). Transfer cognitions have also been shown to mediate the relation between regular exercise at one time point and healthy eating at a later time point (Fleig et al., 2014).

Compensatory health beliefs. Compensatory health beliefs represent a self-regulation strategy via which people hold the beliefs that they can undo, or compensate for, the negative repercussions associated with performing an unhealthy behavior by engaging in a healthy behavior later (Knäuper, Rabiau, Cohen, & Patriciu, 2004; Rabiau,

Knäuper, & Miquelon, 2006). Knäuper et al. (2004) propose that compensatory health beliefs can be activated either in anticipation of or after completing an unhealthy, but pleasurable behavior. They further suggest that compensatory health beliefs are activated for the purpose of reducing cognitive dissonance (Festinger, 1957) that may arise in association with the performance of the unhealthy behavior. This activation of compensatory health beliefs will not detrimentally affect people's health as long as the healthy behavior that people plan to do later is able to sufficiently compensate for the unhealthy behavior (e.g., a planned exercise session must burn the same number of calories that the person has consumed by indulging in a donut) and as long as people follow through on their intentions to complete the healthy behavior.

Holding compensatory health beliefs has a variety of implications for various health behaviors. People who hold high levels of compensatory health beliefs have lower intentions to be physically active (Berli, Loretini, Radtke, Hornung, & Scholz, 2014) and are more likely to engage in risky health behaviors like drinking alcohol and smoking (Knäuper et al., 2004). Similarly, smokers who hold smoking-specific compensatory health beliefs are less likely to report intentions to quit smoking (Radtke & Scholz, 2012). Furthermore, among dieters, holding compensatory health beliefs is negatively related to adherence to dieting guidelines and weight loss (Miquelon, Knäuper, & Vallerand, 2012), and those who succumbed to the temptation to eat a calorie-dense cookie were more likely to generate compensatory thoughts (Kronick & Knäuper, 2010). Among non-dieters, compensatory health beliefs were negatively related to intentions to avoid unhealthy snacks and to creating action plans for avoiding unhealthy snacks (Amrein, Rackow, Inauen, Radtke, & Scholz, 2017). Although more work needs to be done on

compensatory health beliefs, it appears that people who are more prone to generate and hold these compensatory thoughts are more likely to engage in unhealthy behaviors, possibly because they do not follow through on their intentions to compensate for unhealthy behaviors. However, when people are successful at carrying out their compensatory plans, compensatory health beliefs can serve as a mechanism through which purging spillover (i.e., when an unhealthy behavior is followed by a healthy behavior; Dolan & Galizzi, 2015) occurs.

Cross-behavior cognitions and multiple health behaviors. Relatively few studies have examined *both* transfer and compensation effects, and the evidence that has been generated is primarily correlational. In one study, Nigg, Lee, Hubbard, and Min-Sun (2009) surveyed college students on the frequency with which they smoked, drank alcohol, and were physically active. They suggest that there is evidence for transfer effects in that non-smokers drank less alcohol, physically active students smoked less, and non-drinkers smoked less, whereas they considered the findings that physically active students drank more alcohol and alcohol drinkers were more physically active as evidence for compensation. However, although the authors situated these findings within the literature on both types of cross-behavior cognitions, they did not specifically measure the cognitions and beliefs of their participants. Therefore, the evidence that they provide for transfer and compensation effects is really support for the behavioral co-occurrence of two health-promoting behaviors (which they call a transfer effect) and for the behavioral co-occurrence of a health promoting and an unhealthy behavior (which they call a compensation effect).

In a more recent cross-sectional survey of European adults that measured both exercise and eating behavior as well as cognitions related to these two behaviors at two time points, higher levels of exercise-related transfer cognitions were associated with increased motivation for healthy-eating behavior (and vice versa), and exercise-related compensatory health beliefs were associated with intentions for healthy-eating behavior (and vice versa; Fleig et al., 2015). This study found that people held higher levels of transfer cognitions than compensatory health beliefs, suggesting that transfer effects may be more likely to occur than compensation effects.

Furthermore, these lines of research are limited because they address how one health behavior will influence another over different periods of time. Transfer cognitions appear to refer to a longer duration during which people learn and apply the skills from the regular performance of one health behavior to the regular performance of another health behavior, but do not address how a single, completed health behavior may influence other health behaviors in a shorter time frame. It may be possible that transfer cognitions can be activated in the short-term as well. Additionally, it seems as though compensatory health beliefs can be activated in the short-term in response to the performance of an unhealthy behavior (e.g., Kronick & Knäuper, 2010), but it also seems as though people can hold these beliefs over time and that they can have downstream influences (e.g., Berli et al., 2014; Knäuper et al., 2004).

Summary and Synthesis of Research on Behavioral Spillover

In sum, descriptive evidence suggests that behaviors do have the potential to spillover and to influence each other in three different ways: promotion spillover, permitting spillover, and purging spillover (Dolan & Galizzi, 2015). Promotion spillovers

occur when one behavior influences a second behavior in the same direction. One example of a promotion spillover in the health-behavior literature is the exercise-as-a-gateway hypothesis, for which there is mixed evidence that regular exercise leads to the adoption of other health-promoting behaviors (e.g., Costakis et al., 1999; Dutton et al., 2008; Emmons et al., 1999; Tucker & Reicks, 2002; Wilcox et al., 2000). However, this research is limited in that it is primarily correlational. To explain the correlational findings, researchers within this domain have proposed that after adopting one health behavior (like exercise), people seek to maximize the health benefits by performing others (Tucker & Reicks, 2002) and that thinking about health more generally leads to the adoption of multiple other behaviors (Wilcox et al., 2000). Consistent with this perspective that promotion spillovers (e.g., the spillover from exercise to other health behaviors in the exercise-as-a-gateway hypothesis; Blakely et al., 2004; Nigg et al., 1999; Tucker & Reicks, 2002) can occur through the thoughts that people hold, the concept of transfer cognitions suggests that people will harness the self-regulatory thoughts and strategies from one domain (e.g., exercise) and apply them to support the increase of a similar behavior in a different domain (e.g., another health behavior; Barnett & Ceci, 2002). Finally, returning to initial work on behavior spillover, it is also thought that the performance of one behavior may influence the performance of other similar behaviors by changing people's attitudes and self-image (Frey, 1993; Maki, 2015; Thøgersen, 1999; Thøgersen & Ölander, 2003).

Compensatory health beliefs have been primarily studied from the perspective of purging spillovers in that people who hold these beliefs think that they can compensate for the negative repercussions of doing an unhealthy behavior by engaging in a healthy

behavior later (Knäuper et al., 2004; Rabiau et al., 2006). Although compensatory health beliefs have yet to be conceptualized in this way, from the perspective of permitting spillovers, people may similarly hold opposite compensatory health beliefs that they can compensate for their healthy behavior by engaging in a subsequent unhealthy behavior (i.e., they can engage in self-licensing; de Witt Huberts et al., 2012).

In order to best understand how behavioral spillover can occur between the isolated performances of different health behaviors, it is necessary to integrate and consolidate these findings. Therefore, the present research seeks to better elucidate the mechanisms by which the singular performance of one health behavior may affect the subsequent performance of a second health behavior.

The Present Research

The goal of the present dissertation is to examine the relation between the occurrences of two different health behaviors. From Dolan and Galizzi's (2015) framework on behavioral spillover, it is possible to study four iterations of the performances of two different health behaviors: 1) how a health-promoting behavior encourages the performance of a second health-promoting behavior, 2) how an unhealthy behavior encourages the performance of another unhealthy behavior, 3) how a health-promoting behavior leads to the performance of a different unhealthy behavior, and 4) how an unhealthy behavior can lead to the performance of a subsequent healthy behavior. To narrow the scope of the current research project, the focus here will be on the first iteration: Specifically, how does the performance of a health-promoting behavior at one time point influence the performance of a different health-promoting behavior at a later time point? To investigate this research question, a theoretical model will be described

that delineates the pathways by which the performance of a single instance of one health behavior may influence the performance of a second health behavior.

In the present model, six mechanisms were selected from the explanations that that have previously been proposed for how behavioral spillover occurs. Barnett and Ceci (2002) suggested that after performing one behavior, people may become more confident in themselves or feel more positive about that behavior and then transfer that confidence or attitude to a second behavior, indicating that *self-efficacy* and *attitudes* are two possible transfer cognition mechanisms through which this type of promotion spillover may occur. Additionally, another transfer cognition explanation for the exercise-as-a-gateway behavior hypothesis was that in order to maximize the health benefits from exercise, people choose to do other health behaviors (Tucker & Reicks, 2002), suggesting that the performance of one health behavior may strengthen people's *identification as a healthy person* or *commitment* towards health goals, both of which may then influence subsequent behavior. However, as evidenced by permitting spillovers, it is also possible that the completion of one health behavior may instead lead people be less likely to do a second, health-promoting behavior. A permitting spillover may occur through *depletion of self-control resources* (Baumeister et al., 1998) or through *self-licensing* (de Witt Huberts et al., 2012; Monin & Miller, 2001). It will be argued that self-licensing may occur when the individual perceives that sufficient goal progress has been made.

Taken together, there are six overarching pathways that are proposed in the present model: self-efficacy, attitudes, health-identity strength, health-related goal commitment, health-related goal progress, and self-control resources. It will be argued that the performance of a single instance of one health-promoting behavior can lead to

one of three main effects: 1) the increased likelihood of performing a second, different health-promoting behavior (i.e., a promotion spillover), 2) the decreased likelihood of performing a second, different health-promoting behavior and the increased likelihood of performing a second unhealthy behavior (i.e., a permitting spillover), or 3) no effect on the likelihood of performing a second, different health-promoting behavior. The first effect is likely to occur through transfer cognitions including increased health self-efficacy, health attitudes, health-related goal commitment, and health-related identity strength. The second effect is likely to occur through opposite compensatory health beliefs, including increased perceptions of goal progress that lead to self-licensing and decreases in self-control resources. Finally, the first health behavior should have no influence on the second health behavior when there are increases in behavior-specific self-efficacy and/or behavior-specific attitudes towards the first health behavior.

Proposed Pathways of Influence Between the Performances of Two Different Health Behaviors

The proposed model delineates six different pathways by which the performance of a Health-Promoting Behavior A at Time 1 will affect the likelihood of the performance of a second Health-Promoting Behavior B at Time 2. In order for these pathways to mediate the relation between the two different behaviors, the performance of Health-Promoting Behavior A must affect the psychological construct and then the psychological construct must influence Health-Promoting Behavior B (MacKinnon, Fairchild, & Fritz, 2007). In the following section, each psychological construct will be defined, each psychological variable will be interpreted from the perspective of the most commonly used models of health-behavior change (Glanz, Lewis, & Rimer, 1997; Noar, 2007; Noar

& Zimmerman, 2005), and then evidence for how the performance of a behavior should affect the psychological construct and for how the psychological construct should affect downstream behavior will be reviewed.

Self-efficacy. The first mechanism through which the performance of Health-Promoting Behavior A is predicted to influence the later performance of Health-Promoting Behavior B is self-efficacy.

Definition and proposed pathway. Self-efficacy is a subjective belief that individuals hold about their ability to complete various undertakings or to achieve goals (Bandura, 1977, 1986). It has been theorized from a social-cognitive perspective that successfully adopting one health behavior may increase self-efficacy, which may generalize to other similar behaviors and therefore, increase the individual's likelihood of changing other health behaviors (Emmons et al., 1994). Conversely, trying and failing to adopt a certain health behavior may actually undermine self-efficacy and reduce the likelihood that the individual will attempt to change another health behavior.

Bandura (1977) initially proposed four different pathways by which self-efficacy is acquired: performance accomplishments, vicarious experience, verbal persuasion, and physiological states. Of primary interest here is the performance accomplishments pathway, which proposes that after people have successfully completed or achieved mastery over a given behavior, they will show an increase in self-efficacy. However, when people are unable to successfully complete or achieve mastery over a given behavior, there should be a corresponding decrease in self-efficacy. Bandura posited that performance accomplishments would be the most important predictor of self-efficacy, implying that past behavior is integral to the development of self-efficacy beliefs. In this

pathway, successfully performing Health-Promoting Behavior A should increase the individual's self-efficacy towards health-promoting behaviors in general at Time 1, which should lead to an increased likelihood of the performance of Health-Promoting Behavior B at Time 2.

The role of self-efficacy in previous models of behavior change. Although theories of health-behavior change like the health belief model (Rosenstock, 1974) and the theory of reasoned action (Fishbein, 1967; Fishbein & Ajzen, 1975) initially lacked a self-efficacy predictor, self-efficacy was added to the health belief model in 1988 (Rosenstock, Strecher, & Becker, 1988) and was included under the term of perceived behavioral control in the theory of planned behavior (Ajzen, 1985, 1991). Self-efficacy is also included as a key predictor in social-cognitive theory (Bandura, 1997, 2004; Strecher DeVellis, Becker, & Rosenstock, 1986), and in the transtheoretical model, it is thought to be one of the factors that contributes to the advancement from one stage to the next (Prochaska & DiClemente, 1983; Prochaska & Velicer, 1997). Finally, the self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2000) proposes that competence (i.e., the ability to feel control over and mastery towards an outcome) is a predictor of health-behavior change (Ryan, Patrick, Deci, & Williams, 2008). This consistent inclusion of a self-efficacy construct in the theories and models of health-behavior change suggests that for people to adopt healthy behaviors, they must feel capable of doing these behaviors.

Support for behavior as a predictor of self-efficacy. Much research on health-behavior change examines the effect of interventions designed to increase the performance of a given health behavior on subsequent changes in self-efficacy related to

that same behavior. A review of interventions designed to change substance-abuse behaviors (e.g., smoking, illicit drug use) showed that participation in seven out of ten of these interventions led to corresponding increases in self-efficacy (Hyde, Hankins, Deale, & Marteau, 2008). Although one review yielded some support for physical activity interventions leading to an increase in self-efficacy (Lewis, Marcus, Pate, & Dunn, 2002), a later systematic review and meta-analysis of 27 physical-activity interventions designed to increase physical activity revealed a small, albeit significant relationship (d = 0.16) between the physical-activity interventions and changes in self-efficacy (Ashford, Edmunds, & French, 2010). In support of the importance of performance accomplishments as a predictor of self-efficacy, the interventions that provided feedback on the participants' past behavior yielded a larger effect size ($d = 0.43$) than the interventions that did not ($d = 0.11$).

Support for self-efficacy as a predictor of behavior. Self-efficacy has been shown to be a significant predictor for many different health behaviors including smoking cessation (e.g., Baldwin et al., 2006), reducing alcohol consumption (e.g., Oei & Burrow, 2000), and physical activity in healthy adults (e.g., Kaewthummanukul & Brown, 2006). A recent meta-analysis examined the effects of attitudes, norms, and self-efficacy on intentions for and performance of health behaviors and found that experimentally induced changes in self-efficacy yielded a medium effect (d =0.47) on behavior (Sheeran et al., 2016). Consistent with these findings, a review of the literature examining the extent to which self-efficacy influences health-behavior adoption and maintenance found support for self-efficacy as a predictor of both short- and long-term success for the following individual behaviors: smoking cessation, weight control, contraceptive use, treatment of

alcohol addiction and exercise (Strecher et al., 1986). This review also established that self-efficacy could be successfully manipulated in experimental settings, which in turn, was found to influence health-behavior change.

Specificity of self-efficacy beliefs. One limitation when using self-efficacy as a mechanism by which one health behavior might influence another health behavior is that the construct of self-efficacy has been used primarily in reference to people's beliefs that they can perform a *specific behavior* in a given situation (Bandura, 1977, 1986). The studies reviewed above all refer to the effects of this type of *behavior-specific* self-efficacy. In fact, the majority of early research focused on self-efficacy for specific behaviors, or task-specific self-efficacy (TSSE), as a predictor of behavioral intentions and behavior (Leganger, Kraft, & Røysamb, 2000). There is some evidence that specific self-efficacy beliefs for different health behaviors are related: Grembowski et al. (1993) found that the correlations between self-efficacy beliefs for exercise, dietary fat intake, weight control, alcohol intake, and smoking were small- to medium-sized among older adults. Furthermore, because self-efficacy beliefs for a given behavior were related to outcome expectancies for different health behaviors, the authors concluded that self-efficacy does seem to have some generality in related behavioral domains.

In fact, self-efficacy can vary in its generality (O'Leary, 1985). At the broadest level is the concept of general self-efficacy, which refers to perceived mastery and ability over a wide variety of situations (Sherer et al., 1982). Although general self-efficacy (GSE) is a weaker predictor of specific intentions and behaviors (Ajzen, 1988; Conner & Norman, 1996), it is thought that the successful performance of a given behavior will positively influence both task-specific self-efficacy *and* general self-efficacy (Shelton,

1990). When examined in the realm of health behaviors, there is some evidence to suggest that on its own, general self-efficacy is related to health behaviors. General self-efficacy was positively correlated with the performance of health-promoting behaviors among Korean immigrants (Sohng, Sohng, & Yeom, 2002) and was a strong predictor of a variety of general health-promoting behaviors, such as exercise and healthy eating in a disabled population (Becker, Stuifbergen, Ingalsbe, & Sands, 1989). Additionally, general self-efficacy was a predictor of long-term weight loss in an obese population (Wiltink et al., 2007).

Only a handful of studies have examined the relation between measures of general self-efficacy and task-specific self-efficacy and intentions to complete health behaviors or the performance of health behaviors. In one such study, general self-efficacy was strongly related to task-specific self-efficacy for smoking cessation, and task-specific self-efficacy for smoking cessation was related to intentions to quit smoking, but there was no relation between general self-efficacy and intentions to quit smoking (Leganger et al., 2000). In another study that focused on exercise, general self-efficacy was measured in a way that was more specific to physical behavior versus a wider range of health behaviors in that it measured participants' confidence in their physical abilities, not their confidence in their abilities to perform multiple, different health behaviors, and the task-specific self-efficacy measure examined people's self-rated ability to exercise three times per week (McAuley, 1992). In this case, general self-efficacy was related to intensity of exercise and task-specific self-efficacy was related to the frequency of exercise.

Health self-efficacy. Although general self-efficacy was related to and predictive of health-promoting behaviors (Becker et al., 1989; Sohng et al., 2002), the principle of

compatibility suggests that there should be higher levels of agreement between an attitude and a behavior at similar levels of specificity (Ajzen & Fishbein, 1977). When examining multiple, different health behaviors, it may be ideal to use a measure of self-efficacy that is more specific regarding health behaviors than a general self-efficacy measure would be, but that is still broader than behavior-specific self-efficacy. In order to address this gap in understanding efficacy for health behaviors broadly, Becker, Stuifbergen, Oh, and Hall (1993) created an intermediary measure of health self-efficacy that pertains to health-promoting behaviors in general.

This construct of health self-efficacy has been studied both among people with and without chronic conditions, although to date, it does not appear that it has been directly compared to measures of behavior-specific self-efficacy. It is positively related to the performance of health-promoting behaviors among individuals with various chronic conditions including post-polio syndrome (Stuifbergen, Seraphine, Harrison, & Adachi, 2005), disabilities (Stuifbergen & Becker, 1994), and fibromyalgia (Beal, Stuifbergen, & Brown, 2009). Beyond individuals with chronic conditions, health self-efficacy was positively associated with participation in a health-promoting lifestyle among college students (Jackson, Tucker, & Herman, 2007) and with self-rated health in men over the age of 45 (Arras, Ogletree, & Welshimer, 2006).

Hypothesized self-efficacy pathways. It follows that performing Health-Promoting Behavior A at Time 1 will lead to an increase in health self-efficacy, which should lead to an increased likelihood of performing Health-Promoting Behavior B at Time 2. Performing Health-Promoting Behavior A at time 1 will also lead to an increase in behavior-specific self-efficacy for Behavior A, which should be unrelated to the

likelihood of performing Health-Promoting Behavior B at Time 2. In the same way that self-efficacy is predicted to serve as a mechanism by which a promotion spillover between two different health behaviors occurs, attitudes should function similarly.

Attitudes. Therefore, the second pathway through which the performance of Health-Promoting Behavior A at Time 1 should affect the performance of Health-Promoting Behavior B at Time 2 is by influencing the individual's attitudes.

Definition and proposed pathway. An attitude is defined as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993, p. 1). It follows that attitudes are inherently internal psychological states and can be manifested cognitively, affectively, or behaviorally in either explicit or implicit ways (Eagly & Chaiken, 1993). Furthermore, an attitude can have either positive or negative valence and can vary in its degree of extremity (i.e., its difference from neutrality; Eagly & Chaiken, 1993). A substantial amount of psychological research suggests that people can learn their attitudes through observation of their own behavior (e.g., Bem, 1972) and that people strive to maintain consistency between their attitudes and behaviors (e.g., Festinger, 1957). Like the self-efficacy pathway, this will also be a two-step process. First, the successful performance of Health-Promoting Behavior A should increase positive attitudes towards healthy living in general and towards Health-Promoting Behavior A specifically. Second, to maintain consistency between the individual's attitudes and actions, these positive attitudes towards healthy living should influence the performance of a subsequent health behavior.

The role of attitudes in previous models of behavior change. Most theories of health-behavior change include attitudes as a precipitating factor. Rosenstock's (1974)

health belief model proposes that when the perceived benefits of performing a behavior are greater than the perceived costs, attitudes towards the behavior are likely to be positive, and the individual should be more likely to engage in the behavior and vice versa. However, the perceived costs and benefits are thought to be specific to the behavior at hand, and from a health belief model perspective, attitudes may not be applicable to multiple, different health behaviors. Similarly, both the theory of reasoned action (Fishbein, 1967; Fishbein & Ajzen, 1975) and the theory of planned behavior (Ajzen, 1985, 1991) include attitudes towards the behavior as predictors of intentions to perform the behavior. However, in social cognitive theory (Bandura, 1997, 2004; Strecher et al., 1986), the construct that is most closely related to attitudes is that of outcome expectations. Social cognitive theory predicts that if people have more positive (negative) outcome expectations towards the behavior, then they should have a more positive (negative) attitude towards it, and therefore be more (less) likely to perform it. Depending on the abstractness of the outcome expectation (e.g., becoming healthy as an abstract expectation versus being able to complete a marathon as a more specific expectation), it is possible that corresponding attitude may spill over to other behaviors when the outcome expectation is abstract because the more abstract the outcome expectation, the more likely that the corresponding attitude may also be applicable to a different health behavior.

Support for behavior as a predictor of attitudes. As previously discussed, Bem's (1972) self-perception theory proposes that people infer their attitudes towards a particular behavior through the observation of their own actions. Therefore, past behavior should influence present attitudes through self-perception processes. In support of this

idea, experimentally manipulating feedback about past behavior has been shown to affect behavior-relevant attitudes (Albarracín & Wyer, 2000). Similarly, when subjects are provided with a cue that their beliefs may originate from their behaviors, they report stronger attitudes towards a behavior that they have committed to performing (Kiesler, Nisbett, & Zanna, 1969).

Within the realm of health-behavior research, there is evidence that past behavior is related to attitudes towards the same behavior. One meta-analysis examined the effectiveness of the components of the theory of planned behavior and past behavior on various health behaviors and found that past behavior had a medium-sized correlation with attitudes (mean $\rho = 0.32$; McEachan, Conner, Taylor, & Lawton, 2011). Similarly, in a study of the predictive validity of the components of the theory of planned behavior for current and past physical activity behavior in children, past physical activity behavior was a significant predictor of their attitudes towards physical activity (Hagger, Chatzisarantis, Biddle, & Orbell, 2001). These findings support the prediction that the completed performance of a health behavior should positively influence attitudes towards that same behavior.

Support for attitudes as a predictor of behavior. An enormous amount of research has been conducted examining the relation between attitudes and behavior (Ajzen, 2001). A meta-analysis of studies using the theory of planned behavior found a significant correlation between attitudes and behavioral intentions (Armitage & Conner, 2001). In an examination of the relation between attitudes and actual behavior, one meta-analysis suggests that attitude-behavior correspondence is highest when the attitude is stable over time, when the individual feels certain about the attitude, and when there is

consistency between the person's feelings and thoughts about the behavior (Cooke & Sheeran, 2004). Furthermore, a more recent meta-analysis suggests that the attitude-behavior relation is strongest when the attitude itself is easily accessible due to personal experience with the attitude object or due to frequently reporting the attitude (Glasman & Albarracín, 2006). The relation is also strong when the attitude is stable over time due to confidence in the attitude, when the attitude is formed from behavior-relevant information, or when the attitude is formed after thinking about one-side of the attitudinal object (Glasman & Albarracín, 2006).

Within the domain of health behaviors, there is evidence for a strong relation between attitudes and behavioral intentions, as well as between attitudes towards a given behavior and the performance of that particular behavior. One review examined the theory of planned behavior constructs and various health behaviors and found a correlation of 0.46 between attitudes and behavioral intentions (Godin & Kok, 1996). Other meta-analyses have examined the more specific relation between attitudes and a single health behavior. In a meta-analysis of the components of the theory of reasoned action and the theory of planned behavior and exercise behavior, there was a strong effect size for the relation between attitudes and exercise behavior ($d = 0.84$; Hausenblas, Carron, & Mack, 1997). Similarly, another meta-analysis examining the components of the theory of reasoned action and the theory of planned behavior in relation to condom use found that attitudes were more strongly correlated with behavioral intentions ($r = 0.58$) than were subjective norms or perceived behavioral control (Albarracín, Johnson, Fishbeing, & Muellerleile, 2001). Finally, a meta-analysis by Sheeran et al. (2016) examined the effects of attitudes, norms, and self-efficacy on intentions for and

performance of health behaviors and found that experimentally-induced changes in attitudes yield a small effect ($d = 0.38$) on behavior, providing experimental evidence for the attitude-behavior relationship.

Specificity of attitudes. Like self-efficacy, one limitation when using attitudes as a mechanism by which one health behavior may influence another health behavior is that attitudes can vary in their level of specificity, that is, whether they are related broadly to health in general or related specifically to the behavior of interest. As before, the principle of correspondence posits that attitudes will be more strongly related to behaviors when the attitudinal measure is more closely related to the behavior of interest (Ajzen & Fishbein, 1977). In accordance with this principle, some evidence suggests that specificity of the attitude towards the behavior is an important consideration. Global attitudes towards health, including attitudes towards medical services and concern about illness, were unrelated to specific health behaviors, whereas specific attitudes towards a health behavior were more strongly related to its performance (Ajzen & Timko, 1986). It follows that a specific health behavior is likely to be most strongly related to an equally specific measure of attitudes towards that same behavior. This suggests that the performance of one health behavior may increase positive attitudes towards that specific health behavior, but due to the principle of correspondence, that specific attitude increase may not be sufficient to influence the performance of a second, different health behavior.

However, although general health attitudes may not directly predict specific health behaviors, they may increase the positivity of specific health attitudes, which eventually may lead to other health behaviors. For example, Ajzen and Timko (1986) found that people's general health attitudes were related to their specific health attitudes.

Therefore, if performing Health-Promoting Behavior A positively increases general attitudes towards health behaviors, this could lead to increased positive attitudes for Health-Promoting Behavior B, which might increase the likelihood of its performance.

Hypothesized attitudes pathways. Taken together, performing Health-Promoting Behavior A at Time 1 will improve people's general attitudes towards health, which will positively influence the likelihood of performing Health-Promoting Behavior B at Time 2. However, the performance of Health-Promoting Behavior A at Time 1 should also increase people's positive attitudes towards that specific health behavior; the increase of which should be unrelated to the likelihood that the individual will perform Health-Promoting Behavior B at Time 2. Similar to how general health attitudes should lead to a promotion spillover between two health behaviors, health-identity strength should also serve as a pathway linking the performance of two different health-promoting behaviors.

Identity. The third psychological pathway by which performing Health-Promoting Behavior A at Time 1 will influence the performance of Health-Promoting Behavior B at Time 2 is by strengthening the person's health identity.

Definition and proposed pathway. For the most part, the study of identity and health has examined people's role identities as they pertain to a specific health behavior, such as exercise identity, or the extent to which people view exercise as an essential part of their self-concept (e.g., Anderson & Cychosz, 1994; Anderson & Cychosz, 1995), or healthy-eater identity, meaning the extent to which people consider healthy eating to be integral to their self-concept (e.g., Sparks & Shepherd, 1992; Strachan & Brawley, 2009). More broadly, health identity has been defined in adolescents as their "observations and expectations of their own health and the way their health relates and compares to the

health of others and to their knowledge about health" (Grabowski & Rasmussen, 2014, p. 69). However, for the purposes of this research, health identity will be defined using a modified definition from the environmental behavior literature as the extent to which individuals see themselves as someone who does healthy behaviors (Van der Werff, Steg, & Keizer, 2014). In this pathway, performing Health-Promoting Behavior A will strengthen the individual's health identity at Time 1, which will lead to an increased likelihood of performing Health-Promoting Behavior B at Time 2. This pathway should work through two steps: First, the performance of Health-Promoting Behavior A will strengthen the person's identity as someone who engages in healthy behaviors. Second, to maintain consistency between the individual's identity and actions, the increased salience of the health identity should be associated with subsequent healthy behavior. This self-perception process is similar to that which is thought to underlie the foot-in-the-door phenomenon, in which initial compliance with a smaller request increases the likelihood that people will later comply with a much larger target request (Freedman & Fraser, 1966; Snyder & Cunningham, 1975).

Although people's identities can be relatively stable over time, there is accumulating evidence that identity does change and that different facets of the self may become more prominent at different times, essentially fluctuating with systematic changes in the social environment (Markus & Kunda, 1986; Markus & Wurf, 1987; Turner, 1985). The particular facet of the self that emerges at any given time is just one of the many possible identities that combine to comprise the individual's self-concept (Turner, 1985). Stryker (1968) proposed that these multiple identities that people hold are

structured within a "hierarchy of salience," meaning that at any given moment, one identity can be more prominent in the individual's mind than another identity.

This hierarchy of salience is consistent with the idea of the working self-concept (Markus & Wurf, 1987), which suggests that due to the multifaceted nature of the self, only select self-representations or identities will be salient and accessible in the mind at a given time. Furthermore, when there are conflicting self-representations within the self-concept (i.e., individuals may see themselves both as people who engage in healthy behaviors and also as people who indulge in unhealthy behaviors), the self-representation that will be present at any given moment will be a result of which facet has been activated most recently (e.g., Fazio, Effrein, & Falender, 1981). It follows that when people have just completed the performance of a health-promoting behavior, their health identities are likely to be activated and strengthened.

The role of identity in previous models of behavior change. Although none of the major theories of health-behavior change initially addressed identity as a predictor of behavior change, it has since been proposed as an additional, potentially useful predictor in the theory of reasoned action (Fishbein, 1967; Fishbein & Ajzen, 1975) and the theory of planned behavior (Ajzen, 1985, 1991; Biddle, Banks, & Slavings, 1987; Charng, Piliavin, & Callero, 1988; Eagly & Chaiken, 1993; Rhodes, Kaushal, & Quinlan, 2016; Sparks & Guthrie, 1998). A recent meta-analysis of 40 tests that included identity as a predictor in the theory of planned behavior found that it explained an additional 6% of the variance in behavioral intentions over and above the three original predictors (i.e., attitudes, subjective norms, and perceived behavioral control) and an additional 9% of the variance in intentions when past behavior was included with the original three predictors

(Rise, Sheeran, & Hukkelberg, 2010). Although the addition of identity has been supported as a useful predictor in these models, other theories do not explicitly acknowledge identity as a predictor of health-behavior change or maintenance.

Support for behavior as a predictor of identity. Bem's self-perception theory (1972) posits that people come to know and understand themselves by observing their own behavior. Although the majority of work on this theory has focused on how observations of past behavior influence attitudes, more recent work has suggested that these observations should also strengthen the relevant identity (Van der Werff et al., 2014). For example, past blood-donation behavior served as a significant predictor of blood-donation identity (Lee, Piliavin, & Call, 1999). Furthermore, among smokers who were able to successfully quit for at least a year, there was evidence for a shift in identity from "smoker" to "non-smoker" (Vangeli & West, 2012). This suggests that when individuals perform a particular health behavior, it provides information that they are the type of person who does that behavior, thereby making that identity salient.

Support for identity as a predictor of behavior. A number of recent studies have shown that when a given identity is made salient through priming or by asking questions related to that identity, people's subsequent preferences and relevant behaviors tend to be consistent with that identity.

Identity and preferences. To reiterate, there is evidence to support the idea that after a particular facet of the self is made salient, people are more likely to make choices that are consistent with that particular self-representation, as long as the salient identity is one that is already held and valued by the individual (LeBoeuf, Shafir, & Bayuk, 2010). For example, the evocation of a scholarly identity led to the increased likelihood that

participants would select a more academically-oriented magazine (e.g., *The Economist*) compared to the evocation of a socialite identity (LeBoeuf et al., 2010). Similarly, when people's American cultural identity was made salient, they were more likely to choose individualistic options (e.g., owning a unique car) than when people's Chinese cultural identity was elicited (LeBouef et al., 2010). This suggests that for the health behaviors about which people make choices (e.g., when eating, someone can choose either a healthy or an unhealthy option), having a strong health identity should facilitate the healthy choice.

Identity and behavior. Within the realm of health behavior, researchers have examined how behavior-specific identities affect both intentions for particular behaviors, as well as actual health behavior. For example, among smokers, there is evidence that smoker identity (i.e., identification as a person who smokes) has predictive power for smoking behavior over the other predictors in the theory of planned behavior (Moan & Rise, 2005). Similarly, identity as an active individual significantly predicted physical activity behavior over and above the other predictors addressed by the theory of planned behavior (Jackson, Smith, & Conner, 2003). Furthermore, women who were more likely to identify as an exerciser were more likely to report intentions to exercise regularly at the gym and also were more likely to exercise (Theodorakis, 1994). From these studies, it seems that identity can influence behavior, although these studies focus on more stable identities rather than on the identity that is salient at a particular point in time.

Fortunately, a handful of studies have actually manipulated identity salience and then looked at relevant behaviors. In one, bank employees' professional identity was made salient and then they played a coin tossing game in which they had the opportunity

to cheat (Cohn, Fehr, & Maréchal, 2014). The authors hypothesized that within the finance industry, a culture of dishonesty and fraud had been facilitated to the point that the professional identities of bankers may include an inclination to cheat. By observing the expected probability distributions of the coin tosses, the researchers demonstrated that individuals who had had their professional identity as a banker made salient were more likely to cheat during the game than those who had not. Using the same protocol, incarcerated criminals who had been reminded of their identity as a criminal were more likely to cheat during the coin toss game (Cohn, Maréchal, & Noll, 2015). Consistent with the findings on identity salience and preferences, in both studies, the authors found that in order for identity salience to have these behavioral effects, the elicited identity must be one with which the individuals identified. When professionals from industries other than banking were reminded of their professional identity and when ordinary citizens were exposed to crime-related cues, they did not become more likely to exhibit cheating behavior (Cohn et al., 2014; Cohn et al., 2015).

Although these studies refer to the activation of a *specific* identity affecting relevant behavior, work on pro-environmental behaviors has found that increased salience of a *broad-level* environmental identity is a predictor of intentions for a variety of specific pro-environmental behaviors (Van der Werff et al., 2014). Similarly, a broad-level "green identity" predicted a wide range of more specific pro-environmental behaviors including water and energy conservation, waste reduction, and eco-shopping (Whitmarsh & O'Neill, 2010).

Taken together, these findings suggest that after performing a given behavior, the aspects of the self-concept that are consistent with that behavior should be more salient

and readily accessible in the mind (e.g., Bem, 1972; Van der Werff et al., 2014). This salience, in turn, should predict identity-consistent behavior (e.g., Cohn et al., 2014; Cohn et al., 2015). In an initial demonstration of this pathway in the pro-environmental behavior literature, Cornelissen, Pandelaere, Warlop, and Dewitte (2008) made people's environmental identity salient by asking participants to report the frequency with which they performed a number of routine pro-environmental behaviors. In turn, this increased salience of the environmental identity led participants to behave in a more environmentally friendly way. This finding is consistent with the "hypocrisy effect" from the cognitive dissonance literature in which when hypocrisy is induced to arouse dissonance, people are more likely to subsequently behave in a self-consistent manner (Aronson, Fried, & Stone, 1990; Dickerson, Thibodeau, Aronson, & Miller, 1992; Stone, Aronson, Crain, Winslow, & Fried, 1994).

Hypothesized identity pathway. It follows that the performance of Health-Promoting Behavior A at Time 1 will strengthen the salience of individuals' identity that they are the type of person who engages in healthy behaviors, which in turn, will lead to an increased likelihood that they will perform Health-Promoting Behavior B at Time 2. In the same way that increased health identity salience should lead to a promotion spillover between two health behaviors, it can be hypothesized that the performance of one health behavior will also lead to increased commitment to health goals which should lead to the performance of another health behavior.

Goal commitment. Therefore, the fourth mechanism through which performing Health-Promoting Behavior A at Time 1 may influence the performance of Health-Promoting Behavior B at Time 2 is by reinforcing goal commitment.

Definition and proposed pathway. A goal is defined as "what an individual is trying to accomplish; it is the object or aim of action" (Locke, Shaw, Saari, & Latham, 1981, p. 126). More specifically, goal commitment refers to the individual's level of determination to achieve a goal (Locke & Latham, 1990) and is predicted by the attractiveness of goal attainment and the extent to which the individual expects to achieve the goal (Locke, et al., 1981). Within goal setting theory, goal commitment is a central component that functions to moderate the relationship between goal difficulty (i.e., how hard or easy it is to achieve the object of action; Locke et al., 1981) and people's actual performance towards the goal, such that the highest level of performance results from the combination of both high goal difficulty and high goal commitment (Klein, Wesson, Hollenbeck, & Alge, 1999).

When applying goal setting theory to the area of health-behavior change, it is first important to define the various levels of goals and to distinguish between abstract and specific goals (Locke & Latham, 1990). Health goals are defined as broad, abstract desires to promote good health and to prevent illness (Gollwitzer & Oettingen, 1998) and are generally viewed at the highest level of the hierarchy of goals (Maes & Gebhardt, 2000). In order to meet this broad-level health goal, people can implement more specific, lower-level health behavior-related sub-goals (e.g., regular exercise, smoking cessation, etc.; Fishbach, Dhar, & Zhang, 2006; Maes & Gebhart, 2000). Fishbach et al. (2006) argue that completing a single instance of a lower-level health behavior (e.g., an acute exercise session) can either reinforce commitment towards one's ultimate goal of health (e.g., Bem, 1972) or can be perceived as making progress towards the goal (e.g., Carver & Scheier, 1998). These different perceptions should have differential effects on

subsequent behaviors. In the present pathway, the focus will be on when the performance of a health-promoting behavior is perceived as increasing commitment towards health goals. This increased commitment should lead people to pursue goal-consistent behaviors such as a subsequent, different health-promoting behavior.

The role of goal commitment in previous models of behavior change. Although it seems plausible that goal setting should influence behavior change, the early models and theories of health-behavior change do not sufficiently address personal goals and how people choose to meet their goals (Maes & Gebhardt, 2000). Although the theory of reasoned action (Fishbein, 1967; Fishbein & Ajzen, 1975) and the theory of planned behavior (Ajzen, 1985, 1991) treat "intentions" as a component that is specific to the health behavior that they are meant to predict, they do not recognize health goals broadly. Researchers tend to interpret the behavioral intentions component of these theories as a more specific goal (Gollwitzer & Oettingen, 1998) because it captures the individual's commitment towards completing a specific behavior.

However, social cognitive theory (Bandura, 1997, 2004; Strecher et al., 1986) does explicitly address goals. In social cognitive theory, goals are incorporated as the health goals that people set for themselves as well as the plans and strategies that they make to help meet them. The self-determination theory model of health-behavior change (Ryan et al., 2008) also includes goals and posits that people can have a broad health goal to change their physical health as long as their basic psychological needs (i.e., autonomy, competence, and relatedness) are met. The model suggests that increased motivation for physical health generally can lead to health-behavior change across a variety of health behaviors (e.g., smoking, exercise, weight loss). However, this model only suggests that

the performance of these behaviors should be correlated with one another, but does not necessarily imply that they will influence one another.

Support for behavior as a predictor of goal commitment. Through self-perception (Bem, 1972), the successful performance of a given behavior may be used to ascertain one's level of commitment towards achieving a broader goal (e.g., Bem, 1972; Soman & Cheema, 2004), which should then be followed by goal-consistent actions. However, if the actor evaluates a given performance of a particular behavior as a failure, this perception leads to subsequent decreases in self-efficacy, which in turn leads to reduced goal commitment (Bandura & Simon, 1977). Therefore, when the performance of the behavior is considered a success, goal commitment should increase, but when the performance of the behavior is considered a failure, goal commitment should decrease.

Support for goal commitment as a predictor of behavior. Meta-analytic evidence supports the premise from goal-setting theory that people who are more strongly committed to their goals achieve greater levels of objective task performance (Klein et al., 1999). This relationship is moderated by goal difficulty, such that task performance is greatest when both goal commitment and goal difficulty are high (Klein et al., 1999).

Furthermore, there is evidence to suggest that when the completion of a sub-goal reinforces individuals' goal commitment toward their ultimate goal, it can lead to the performance of subsequent behaviors that serve to further that superordinate goal. In one study, Fishbach and Dhar (2005) found that when performing a certain behavior reminded people of their commitment to a goal, they were more likely to pursue subsequent goal-consistent behaviors. In another series of studies, after people were primed with a superordinate goal in order to increase goal commitment, the successful

completion of an initial sub-goal led to increased interest in performing a second goal-consistent action (Fishbach et al., 2006).

Hypothesized goal commitment pathway. Therefore, if performing Health-Promoting Behavior A at Time 1 is perceived as a success, it should strengthen commitment to superordinate health-related goals, which will in turn lead to an increased likelihood of performing a goal-consistent Health-Promoting Behavior B at Time 2. However, it is also possible that the successful performance of Health-Promoting Behavior A will be perceived as making progress towards one's superordinate goals (e.g., Carver & Scheier, 1998), which may instead lead to self-licensing behavior.

Goal progress. It follows that the fifth pathway by which performing Health-Promoting Behavior A at Time 1 may affect the performance of Health-Promoting Behavior B at Time 2 is through perceptions of goal progress.

Definition and proposed pathway. Goal progress is defined as how close someone feels to meeting a goal and is determined by the active pursuit of that particular goal (Fishbach & Dhar, 2005). As noted previously, the performance of a single instance of a lower-level health behavior (e.g., an exercise session) can either reinforce commitment to an overarching goal of health (e.g., Bem, 1972) or can be perceived as making progress towards the goal (e.g., Carver & Scheier, 1998; Fishbach et al., 2006), and these perceptions will differentially influence subsequent behaviors. Here, the focus is on when people perceive that the completion of Health-Promoting Behavior A indicates that progress towards a goal has been made. If they perceive goal progress, they may justify to themselves that sufficient effort has been expended towards the goal. Using that justification, they may then be less likely to perform Health-Promoting

Behavior B at Time 2 because they have already met a health goal. In this way, perceptions of goal progress may serve as a justification for people to self-license and to perform a subsequent indulgent behavior.

Self-licensing. Self-licensing is defined as people's reliance on reasons and arguments to rationalize subsequent indulgent behaviors (de Witt Huberts et al., 2012) and originated from a finding in decision-making research that individuals were more likely to choose an option that could be more readily justified (Shafir, Simonson, & Tversky, 1993). A specific form of self-licensing called moral self-licensing refers to the phenomenon in which after doing a moral behavior, people then feel licensed to perform a subsequent behavior that actually goes against these moral principles (Monin & Miller, 2001). Meta-analytic evidence suggests that this is a significant effect, but of a small to medium effect size ($d = 0.31$; Blanken, van de Ven, & Zeelenberg, 2015). It follows that when an individual has dedicated some amount of effort towards a goal so as to perceive that progress has been made in that domain, this perception of goal progress may be sufficient to warrant justification for subsequent self-licensing in a different domain.

Some researchers have tested the concept of self-licensing in the domain of health behaviors. In one study, when participants were induced to perceive themselves as exerting more effort at a task (i.e., they thought they were doing the task twice compared to control participants who only did the task once, but for the same amount of time), they then consumed more hedonic snacks, which was interpreted as self-licensing (de Witt Huberts et al., 2012). Furthermore, simply reflecting on a time when one had expended effort to resist buying an attractive product led to self-licensing when eating, such that

individuals were more likely to choose a piece of chocolate cake over a fruit salad (Mukhopadhyay & Johar, 2009).

The role of goal progress in previous models of behavior change. Although the health belief model (Rosenstock, 1974) does not explicitly address goals, it has a component called "perceived threat" that may lead to opposing predictions from the perspective of goal progress. If the perceived threat to one's health is thought to be severe and people feel personally susceptible to it, then they should want to reduce it, and therefore would have a health goal of reducing the perceived threat. Consequently, if performing Health-Promoting Behavior A either somewhat or entirely reduces the perceived threat, then people will feel that they have made sufficient progress toward this health goal, and therefore may actually be less likely to perform a goal-consistent subsequent Health-Promoting Behavior B, which is consistent with the self-licensing perspective (Fishbach & Dhar, 2005). Conversely, if performing Health-Promoting Behavior A cannot adequately address the perceived threat, then the individual has not made sufficient progress towards the health goal, meaning that it will remain salient, and the person may be more likely to perform Health-Promoting Behavior B (Fishbach & Dhar, 2005).

Dolan and Galizzi's (2015) framework of behavior spillover both directly and indirectly addresses how perceptions of goal progress may contribute to behavior spillover. They suggest that Amir and Ariely's (2008) "resting on laurels" effect may be one pathway through which a permitting spillover (i.e., when the performance of a health-promoting behavior prompts the performance of a subsequent unhealthy behavior) occurs. In essence, the resting-on-laurels effect posits that perceived progress towards a

sub-goal leads to less effort being invested into the ultimate goal. Their framework also indirectly acknowledges goals within the moral self-licensing pathway for permitting spillover. In their model, if the person has done "well" on the first behavior, they can then permit themselves to indulge on the second behavior. This is consistent with the present idea of perceptions of goal progress leading to self-licensing: In order for individuals to perceive that they have done well on the first behavior, they must believe that they have made sufficient progress towards their goal, and then, they may be inclined to self-license with a subsequent unhealthy behavior.

Support for behavior as a predictor of goal progress. By definition, in order for people to infer that goal progress has been made, some behavior towards the goal must be completed. However, behaviors will vary in the extent to which their completion increases perceptions of progress towards a given goal (Amir & Ariely, 2008). Research suggests that when the performance of a given behavior is perceived as accomplishing a specific sub-goal within a broader-level goal, that achievement will indicate that goal progress has been made (Brunstein, 1993; Cantor & Kihlstrom, 1987).

However, individuals can vary in the extent to which they are certain that they are progressing toward a goal. In some situations, individuals know exactly how much closer the completion of one behavior brings them towards achieving their goal (e.g., completing an exercise session when the goal is to exercise three times per week), whereas in other situations, they do not (e.g., eating a salad when the goal is to be healthier; Amir & Ariely, 2008). It thus follows that when the performance of a health behavior is interpreted as completing a sub-goal that serves to further a superordinate

goal, perceptions of goal progress should be more certain than when the performance of a health behavior is ambiguous with regard to achieving a superordinate goal.

Support for goal progress as a predictor of behavior. Initial work on goal progress suggested that when certainty of progress towards a problem-solving task was high, people increased their effort towards achieving the goal (Newell & Simon, 1972) and that signals of increasing goal progress towards the endpoint were likely to increase overall performance (Locke & Latham, 1990; Pervin, 1989). However, perceptions of goal progress have a more complicated relation with subsequent behavior when considering the certainty of progress towards the ultimate goal and the presence of discrete progress markers (Amir & Ariely, 2008). Discrete progress markers provide information about the exact distance a person is from the goal. A series of studies by Amir and Ariely demonstrated that when progress uncertainty was high, the presence of discrete progress markers served to reduce uncertainty, improve overall performance, increase effort, and increase the likelihood that people would do the task again. Conversely, when progress certainty was high, the presence of discrete progress markers undermined overall performance, made it less likely that they would increase their effort, and made it less likely that they would choose to do the task again. The authors posited that this may be because the discrete progress markers made individuals feel complacent towards their ultimate goal, distracted motivated from the final goal, and reduced the appeal of the eventual goal.

There is also evidence for self-licensing behavior after thinking that goal progress has been made. When individuals hold multiple, sometimes conflicting goals (e.g., wanting to exercise regularly and simultaneously wanting to eat indulgent foods), after

being reminded of the progress that they made towards one goal, they were more likely to compensate by selecting an option that was counterproductive towards that goal, but consistent with a competing goal (Fishbach & Dhar, 2005).

Hypothesized goal progress pathway. If performing Health-Promoting Behavior A at Time 1 leads to the perception that goal progress has been made, it should lead to a decreased likelihood of performing a Health-Promoting Behavior B that is consistent with an overarching health goal at Time 2. Similarly, it is likely that there will be a decreased likelihood of performing Health-Promoting Behavior B at Time 2 when the performance of Health-Promoting Behavior A at Time 1 leads to a decrease in self-control resources.

Self-control resources. Therefore, the final pathway by which the performance of Health-Promoting Behavior A at Time 1 may decrease the likelihood of performance of Health-Promoting Behavior B at Time 2 is by decreasing people's self-control resources.

Definition and proposed pathway. Self-control is defined as "the exertion of control over the self by the self" (Muraven & Baumeister, 2000, p. 247). The concept of ego depletion within the strength model of self-control (Baumeister et al., 1998; Muraven & Baumeister, 2000) suggests that self-control is a limited resource shared by all acts of volition and that using self-control to enact one behavior will reduce the amount of self-control available to enact a later behavior. In essence, when in a state of ego depletion, people lack full use of their self-control resources (Baumeister & Vohs, 2007). It follows that if self-control is required to enact a given health behavior (e.g., choosing to eat a healthy, lean meal when it requires resisting the urge to eat a tasty, highly fattening meal), then the performance of that particular behavior should lead to reduced levels of

self-control, which may reduce the likelihood that the individual will be able to perform a subsequent health-promoting behavior that also requires self-control.

The role of self-control resources in previous models of behavior change. Although most of the models and theories of health-behavior change that have already been discussed (i.e., the health belief model, the theory of reasoned action, the theory of planned behavior, social cognitive theory, and the transtheoretical model) do not explicitly acknowledge ego depletion or levels of self-control resources, Dolan and Galizzi (2015) consider ego depletion as the prototypical way by which permitting spillovers occur between a positive behavior followed by a negative behavior. That is, if the performance of the first, positive behavior (e.g., a health-promoting behavior) requires high levels of self-control, then the individual should have reduced levels of self-control resources to expend on performing a subsequent behavior, leading to the performance of a negative behavior (e.g., an unhealthy behavior).

Support for behavior as a predictor of self-control resources. Many different behaviors are thought to require self-regulatory resources. Any behavior for which the individual must override an impulse (e.g., the desire to stay in bed and skip an exercise session) in order to accomplish a personal goal (e.g., exercising as a way to improve cardiovascular health) is thought to require self-control. Much of the work on self-control uses what is called a *sequential task paradigm* in which there is a manipulation task followed by an outcome task (Carter, Kofler, Forster, & McCullogh, 2015). The logic behind this paradigm is that performing a behavior that requires self-control in the manipulation task should lead to lower levels of self-control, which should then worsen

performance on a subsequent behavior that required self-control in the outcome task (Baumeister et al., 1998; Murven, Tice, & Baumeister, 1998).

Since the development of this paradigm, many different behaviors have been used for the manipulation task (Carter et al., 2015). Among the most frequently used behaviors designed to lower levels of self-control resources include writing an essay while avoiding the use of specific commonly-used letters, focusing one's attention (e.g., Muraven et al., 1998), suppressing one's emotions (e.g., Baumeister et al., 1998), completing difficult math problems, and performing a Stroop task (Carter et al., 2015). These manipulation tasks have been shown to reduce subsequent levels of self-control resources on various outcome tasks including the amount of food participants consume (e.g., Vohs & Heatherton, 2000), how long participants persist at different tasks such as an isometric handgrip hold (Bray, Ginis, Hicks, & Woodgate, 2008; Muraven et al., 1998), a frustrating/unsolvable puzzle (Baumeister et al., 1998; Muraven et al., 1998), and a second Stroop task (Carter et al., 2015).

Within the realm of health, a number of different health behaviors requiring self-control have been harnessed to lower self-control resources in the manipulation task. For example, asking participants to override their desires and to eat healthy, unappetizing foods in the face of competing, tasty options and having them sit in front of and resist eating tasty, tempting foods have been used as behaviors that lead to self-regulatory depletion (Hagger, Wood, Stiff, & Chatzisarantis, 2009). In an initial demonstration of this idea that healthy eating could lead to ego depletion, Baumeister et al. (1998) found that when participants were asked to exhibit self-control and eat radishes while in the presence of more appetizing foods like chocolate and cookies, they then showed reduced

persistence on a subsequent self-control task compared to individuals who did not have to regulate their eating. Resisting the temptation to eat indulgent foods consistently leads to decreases in self-control (e.g., DeWall, Baumeister, Stillman, & Gaillot, 2007; Muraven, Schmueli, & Burkley, 2006). Similar effects have been found for alcohol consumption. Operating under the assumption that for social drinkers, simply smelling alcohol would lead to a desire to drink that would require self-control that would need to be suppressed if an alcoholic beverage was not readily available, participants who sniffed alcohol (versus a neutral stimulus) showed increased ego depletion and decreased performance on a later self-control task (Muraven & Schmueli, 2006).

Support for ego depletion/self-control as a predictor of behavior. A large body of research initially demonstrated that temporary reductions in state self-control as a result of ego depletion affect the performance of subsequent self-control behaviors. A 2010 meta-analysis of 198 published experiments suggested that ego depletion is a robust effect, with a Cohen's *d* of 0.62 (Hagger, Wood, Stiff, & Chatzisarantis, 2010).

In particular, decreases in self-control resources were shown to influence subsequent health behaviors. This effect was demonstrated for eating behavior, such that following self-control depletion tasks, people were more likely to indulge in tasty foods (e.g., Kahan, Polivy, & Herman, 2003; Vohs & Heatherton, 2000). Similarly, individuals who underwent a self-control depletion task in the laboratory (e.g., a Stroop task) demonstrated more unrestrained sexual behavior and were more likely to indicate that they would be unfaithful to a partner compared to non-depleted controls (Gailliot & Baumeister, 2006). Individuals with depleted self-control resources have also shown a tendency to drink more alcohol (Muraven, Collins, & Nienhaus, 2002) and to smoke

cigarettes (Shmueli & Prochaska, 2009) compared to non-depleted individuals. In an examination of depletion outside of the laboratory, Oaten and Cheng (2005) found that university students who were depleted due to exam stress were less likely to engage in health-promoting behaviors that required self-control (e.g., physical activity).

However, despite these findings, two recent investigations on the ego-depletion effect suggest that it may not be as robust of an effect as early evidence would suggest. For one, using more stringent inclusion criteria and improved statistical analyses, a recent meta-analysis did not find evidence to support the ego depletion effect (Carter et al., 2015). Furthermore, the researchers specifically examined the effects of ego depletion on various frequently used outcome behaviors and did not find a significant effect of ego depletion on eating behavior (Carter et al., 2015). Second, a group of 23 laboratories tested the ego-depletion effect in a pre-registered replication attempt of a single ego depletion protocol and found a null effect of ego depletion in that the vast majority of the laboratories' data included zero in the 95% confidence interval (Hagger et al., 2015).

These findings suggest that self-control resource depletion may not be a robust enough of an effect to detect. However, in order to ensure that the possible mechanisms by which the performance of one health behavior may affect the later performance of a different health behavior are examined, the idea that performing one health-promoting behavior will decrease self-control resources which in turn will reduce the likelihood that a second health-promoting behavior will be performed will still be tested.

Hypothesized self-control resources pathway. Taken together, if performing Health-Promoting Behavior A at Time 1 requires self-control, it will reduce the individual's level of self-control resources that are available, which may then decrease

the likelihood that the individual will perform Health-Promoting Behavior B at Time 2, especially if Behavior B requires self-control.

Summary of the proposed model. In sum, the proposed model provides a novel conceptualization for the mechanisms by which the performance of a single Health-Promoting Behavior A at Time 1 will affect the subsequent performance of a different Health-Promoting Behavior B at Time 2. Six different mechanisms have been presented: self-efficacy, attitudes, identity strength, goal commitment, goal progress, and self-control resources. It is predicted that the performance of Health-Related Behavior A will lead to one three main effects: 1) the increased likelihood of performing Health-Related Behavior B (i.e., a promotion spillover through short-term transfer cognitions), 2) the decreased likelihood of performing Health-Related Behavior B and the increased likelihood of performing a second unhealthy behavior (i.e., a permitting spillover through opposite compensatory beliefs), or 3) no effect on the likelihood of performing Health-Related Behavior B at Time 2. The first effect is likely to occur through transfer cognitions that are activated in the short-term, including increased health self-efficacy, health attitudes, health identity strength, and health goal commitment. The second effect is likely to occur through opposite compensatory health beliefs including increased perceptions of goal progress leading to self-licensing and decreases in self-control resources. Finally, the first health behavior should have no influence on the second behavior when there are increases in behavior-specific self-efficacy and behavior-specific attitudes towards health behavior A. The goal of the present research was to provide a preliminary test of whether the psychological variables presented in this proposed theoretical model changed in response to the completion of one health behavior and

whether those changes led to the differential performance of a second health behavior and then to examine whether manipulating whether the performance of one health behavior could be thought of as leading to a promotion spillover or to a permitting spillover would have the desired effect on a subsequent, different health behavior.

Selection of Target Behaviors

The present research addressed a gap in the literature by using the proposed theoretical model to examine the sequential performances of two different health-related behaviors. The two behaviors that were selected to be the focus of this research are exercise and eating behavior. Exercise and eating behavior have a unique relation in that in order to maintain one's weight, energy intake (i.e., eating behavior) must equal energy expenditure. In today's sedentary society, energy expenditure typically necessitates exercise or increased physical activity in order to match energy intake. However, the reverse relation can also hold, such that when energy expenditure due to physical activity is high, the individual must compensate by eating more.

Many studies have observed correlations between the self-reported performance of physical activity and healthy eating (e.g., Johnson, Nichols, Sallis, & Calfas, 1998; Raitakari et al., 1995; Schuit et al., 2002; Simoes et al., 1995), suggesting that these two behaviors tend to naturally co-occur. The following review will establish that although many studies have examined the relation between exercise and subsequent eating behavior from a *physiological* perspective (i.e., do people compensate for the energy expended during an exercise session by increasing their subsequent energy intake through eating?), only a handful of studies have examined the *psychological* relation between how one thinks about an exercise session and subsequent eating behavior, and that there

is little research on how people's eating behavior affects subsequent exercise behavior. Consequently, the proposed theoretical model provides a novel approach for understanding and testing the psychological relation between these two health-related behaviors, specifically, how the performance of an acute exercise session affects later eating behavior.

Overview of studies examining exercise and eating behavior.

Exercise and energy intake. First, it is necessary to understand whether there are changes in energy intake that take place throughout the day after an acute exercise session is completed. Meta-analytic evidence suggests that completing an exercise session can lead to an overall negative energy balance in that energy intake during the meal or the meals following an exercise session is usually not sufficient to match the energy burned during the exercise session (Schubert, Desbrow, Sabapathy, & Leveritt, 2013). In the studies included in this meta-analysis that offered one ad libitum test meal, participants were given the meal 0-2 hours after the exercise session. In the studies in which a second *ad libitum* test meal was offered, it was given to the participants 4-5 hours after the first meal.

Similarly, many studies have examined the effect of exercise/physical activity on subsequent energy intake both in the short-term and over longer periods of time. These studies have been categorized into five primary types: cross-sectional studies, acute exercise studies, short-term studies, non-randomized trials, and randomized trials (Donnelly et al., 2014). *Cross-sectional studies* compare groups on measures of physical activity and energy intake at a single time point (e.g., Cameos & Lopes, 2008; Hornbuckle, Bassett, & Thompson, 2005; Lee, Djousse, Sesso, Wang, & Buring, 2010).

In *acute exercise studies*, participants complete an exercise session and then energy intake is measured within 24 hours (e.g., Finlayson, Bryant, Blundell, & King, 2009; George & Morganstein, 2003; King, Wasse, Broom, & Stensel, 2010; Lluch, King, & Blundell, 1998, 2000). *Short-term studies* use cross-over designs and compare energy intake over 2-14 days when participants are assigned to an exercise regimen compared to a no-exercise control period (e.g., Staten, 1991; Stubbs et al., 2002). *Non-randomized trials* examine whether energy intake is affected over time in a single experimental group in which all participants are assigned to a longitudinal exercise program, meaning that there is no random assignment to an experimental group and a control group (e.g., Bryant, Caudwell, Hopkins, King, & Blundell, 2012; Martins, Kulseng, King, Holst, & Blundell, 2010). Finally, *randomized trials* compare the effect of exercise on both energy intake and diet macronutrient composition between participants who have been randomly assigned to an exercise program versus a control group (e.g., Cox, Burke, Beilin, & Puddey, 2010; Donnelly et al., 2003; Pritchard, Nowson, & Wark, 1997).

In an extensive systematic review of each of these types of studies examining the relation between exercise and *ad libitum* energy intake (i.e., the amount of calories consumed when participants are allowed to eat freely during a test meal), Donnelly et al. (2014) concluded that there was no clear or consistent effect of increased physical activity or exercise on eating as part of a cross-sectional study, an acute exercise study, a short-term study, a non-randomized longitudinal design, or a randomized longitudinal trial. This relation held for many different exercise parameters including type of exercise (e.g., aerobic, weight-training), intensity, duration, as well as for participant characteristics including age, gender, weight, and baseline level of physical activity.

Furthermore, across studies, there appeared to be no significant effect of exercise on changing the macronutrient composition of people's diets. This review is consistent with previous reviews and meta-analyses of the literature that have found that in the majority of studies, there is no substantial change in energy intake immediately after exercise (Bilski, Teległów, Zahradnik-Bilska, Dembiński, & Warzecha, 2009; King et al., 2013; Melzer, Kayser, Saris, & Pichard, 2005; Schubert et al., 2013) and that acute exercise does not increase levels of hunger (King et al., 2013). Taken together, from a physiological perspective, the evidence suggests that there is no significant effect of an acute exercise session on energy intake.

Thinking about exercise and subsequent eating behavior. Although the actual performance of an acute exercise session has not been found to dramatically influence subsequent energy intake, a number of studies suggest that manipulating the way that people *think* about the performance of an exercise session can affect subsequent eating behavior. In one field study (Werle, Wansink, & Payne, 2011), mall patrons were asked to read a hypothetical scenario in which they went on either a 30-minute walk for fun or on a 30-minute walk for exercise and then were asked to serve themselves a snack. Compared to participants in a control condition who did not read about the hypothetical exercise session, the individuals who read about the walk for exercise served themselves more snacks. This relation was mediated by a biased perception of how many calories were in the snacks, such that the individuals who had imagined exercising were less accurate when asked to estimate how many calories were in the snacks. The authors suggest that if simply thinking about a walk as exercise reminded participants of how much effort is involved in exercising and of how tired exercising may make them, it may

lead to cognitive depletion which could have hindered their ability to estimate the number of calories in the snacks, thereby leading to overcompensation when taking snacks.

Other studies that expose participants to exercise-related cues have reported conflicting results. In one, when participants were exposed to exercise (versus control) messages, they ate more raisins in a subsequent taste test (Albarracín, Wang, & Leeper, 2009). Similarly, when subliminally primed with action (versus control) words, participants consumed more calories (Albarracín et al., 2009). In a separate study examining the effect of fitness cues on food packaging, researchers found that participants served themselves more of a snack when it was called "fitness trail mix" than when it was given a neutral name (Koenigstorfer, Groeppel-Klein, Kettenbaum, & Klicker, 2013).

Conversely, when participants were exposed to exercise (versus neutral) commercials and then served a meal *ad libitum*, they actually reduced their intake by 22% and rated the meal as more healthy and enjoyable (van Kleef, Shimizu, & Wansink, 2011). This reduction in the amount of food consumed was primarily driven by participants with a high BMI. Furthermore, watching the exercise commercials made the participants feel less relaxed, more athletic, healthier, and in better shape compared to the participants who watched the control commercials, suggesting that the idea of exercise for improved health was activated after watching these commercials.

Taken together, these studies provide preliminary support for the idea that manipulating the way that individuals think about a hypothetical exercise session or exposing them to exercise-related cues can have implications for subsequent eating behavior. When individuals were induced to perceive exercise as effortful, they were

more likely to indulge in a snack (Werle et al., 2011). But, when the concept of health was activated in relation to exercise, people actually ate less, particularly when they were overweight (van Kleef et al., 2011).

Perceptions of exercise and subsequent eating behavior. Because simply thinking about an exercise session and being exposed to fitness-related cues influences subsequent eating behavior, recent research has manipulated people's perceptions of actual exercise sessions and then examined eating behavior. In an extension of Werle et al.'s (2011) research that asked participants to *think* about a walk for exercise versus a walk for fun, Werle, Wansink, and Payne (2015) completed two studies in which participants' perceptions of an actual walk were manipulated. When the walk was labeled as exercise (versus as a scenic walk for fun), participants consumed more dessert with lunch in one study and served themselves more of a hedonic snack (i.e., M&Ms) in a second study. Additionally, in a third study, participants in a road race who indicated that they thought that the race was fun were less likely to choose a hedonic snack (Werle et al., 2015). The researchers suggest that when physical activity is considered effortful (i.e., when it is labeled as "exercise"), people are more likely to want a reward for their efforts and are therefore more likely to self-license by selecting a hedonic snack.

In another study, researchers measured whether the participants were low- versus high-behavioral regulators of exercise, manipulated whether an exercise session was labeled as "fat-burning" or for "endurance," and then measured *ad libitum* consumption of a snack (Fenzl, Bartsch, & Koenigstorfer, 2014). Exercisers low in behavioral regulation were defined as individuals who self-imposed exercise and scored higher in external regulation of exercise, and did not express intentions to exercise. These

individuals were less likely to enjoy the exercise session and ate more after the exercise session that was labeled as fat-burning. Exercisers high in behavioral regulation were defined as people who are intrinsically motivated to exercise. They ate less when the exercise was labeled as fat-burning, but ate more in the endurance condition. The authors hypothesized that for people high in behavioral regulation, labeling the exercise as fat-burning may have reminded them that they had not yet reached their long-term goal of burning fat and therefore should remain committed to the goal, and so they were less inclined to snack. This suggests that if completing an exercise session can increase goal commitment towards staying healthy, it may have effects on subsequent snacking.

Eating behavior and subsequent exercise. As established, a substantial amount of research has been conducted examining the relation between the performance of an acute exercise session and subsequent eating behavior. However, to date, there is little research looking at the reverse relation: how eating behavior influences subsequent exercise behavior. One study on this topic found that after participants took a placebo pill that they believed to be a dietary supplement, they then expressed less interest in subsequent exercise and also walked less compared to individuals who were told that they were simply taking a placebo pill (Chiou, Yang, & Wan, 2011).

Recently, the Diet-Related Compensatory Health Beliefs Scale (Diet-CHBS) was developed to examine diet-related compensatory health beliefs, that is, the cognitions people hold regarding compensation behaviors like exercise after eating (Poelman, Vermeer, Vyth, & Steenhuis, 2012). One factor that was identified during scale development is diet-related compensatory beliefs related to exercise and includes items such as, “To maintain your weight, it is fine to have less exercise if you eat small

portions" and "When I eat less, it's not necessary to have a lot of exercise." One study examining compensatory health beliefs between physical activity and healthy nutrition found that people who believed that an unhealthy diet could be compensated for by participating in regular exercise reported lower intentions to stick to a healthy diet (Fleig et al., 2015). This same study also found that when individuals hold diet-specific transfer cognitions (i.e., beliefs that a healthy diet could encourage their physical activity), they were more motivated to participate in regular exercise (Fleig et al., 2015). Although there is some initial research on how eating behavior affects subsequent exercise behavior, it is still limited, and so the focus of the present study will be on the opposite direction of the relation: how exercise behavior affects subsequent eating behavior.

Synthesis of studies examining exercise and eating behavior. Taken together, the research suggests that from a physiological perspective, people tend to be quite good at matching the energy that is expended during exercise with their subsequent energy intake, especially in the short-term (Donnelly et al., 2014). Despite this matched physiological relation between these two health behaviors, there is evidence to suggest that differentially manipulating the ways in which people think about or perceive an exercise session may influence subsequent eating.

To explain this relation, researchers have proposed various explanations, many of which are consistent with the pathways put forward in the present model. For example, the increases in feelings of athleticism and health after watching an exercise commercial suggest that perhaps watching the commercials may have strengthened the participants' health identity (van Kleef et al., 2011). Support for the goal commitment pathway comes from the study in which high behavioral-regulation individuals who perceived an exercise

session as “fat-burning” were less likely to snack afterwards (Fenzl et al., 2014). The authors suggested that this effect was due to the individuals feeling more committed towards a long-term goal of burning fat and not wanting to hinder their long-term goal with a snack. Past research examining self-control resources found that when individuals were instructed to think about going on a walk, there was evidence for a biased, less accurate estimation of the number of calories in a snack, which lead to a greater self-serving of snack foods that the researchers attributed to depleted self-control resources (Werle et al., 2011). However, in a later study, it was suggested that perceiving a walk as exercise (versus as fun) may instead lead to self-licensing in that people want to reward themselves for the effort they invested in the exercise and therefore are more likely to consume more dessert or to select a hedonic snack (Werle et al., 2015). Similarly, it is possible that the studies that demonstrated an effect of exposure to fitness-related cues on subsequent increases in food consumption (e.g., Albarracín et al., 2009; Koenigstorfer et al., 2013) also worked through a self-licensing pathway in that the fitness-related cues suggest that exercise is effortful.

Despite these plausible explanations that are consistent with the pathways in the present model for why differentially thinking about an exercise session may influence subsequent eating, to date, no one has yet explicitly tested these explanations, nor have they considered testing the multiple possible psychological mechanisms by which an exercise session may influence eating behavior. The present research will use the proposed model to address this gap in the literature and to test the multiple pathways by which the performance of an exercise session may influence subsequent eating.

Review of Hypotheses and Project Overview

The goal of the present research was to provide an initial test of the proposed theoretical model by examining 1) whether the completed performance of a health-related behavior (i.e., an acute exercise session) led to the anticipated psychological changes put forward by the model, 2) whether the psychological changes elicited by the performance of one health-related behavior (i.e., an acute exercise session) influenced a subsequent, second health-related behavior (i.e., eating behavior), and 3) whether experimentally manipulating the psychological pathways could influence the relation between these two different health-related behaviors. In order to examine the research questions at hand, two studies were conducted.

Study 1: Naturalistic Changes in the Proposed Psychological Constructs After an Acute Exercise Session

The first study was a within-participants study in which participants completed an acute exercise session of their choice. The primary aim of this study was to compare pre- and post-exercise responses on the measures of the psychological variables in a sample of regular exercisers and to examine the magnitude of any changes that occurred. The pathways that were put forward by the model can be divided into those that should lead to healthy eating behavior (i.e., the promotion spillover pathways consisting of health self-efficacy, health attitudes, strengthening of health identity, and strengthening of commitment towards health goals), those that should lead to unhealthy eating behavior (i.e., the permitting spillover pathways consisting of perceptions of goal progress and self-control resource depletion), and those that should not influence eating behavior (i.e., physical activity self-efficacy and physical activity attitudes).

The secondary aim of this study was to examine whether the predicted psychological changes after an acute exercise session influenced subsequent snack choice. The tertiary aim was to conduct exploratory analyses to examine whether any characteristics of the exercise session itself or the regularity with which participants exercised affected the extent to which any psychological changes were observed. The following hypotheses were specified:

Hypothesis 1a. The completion of an acute exercise session will lead to an increase in health self-efficacy.

Hypothesis 1b. The completion of an acute exercise session will lead to an increase in physical activity self-efficacy.

Hypothesis 1c. The completion of an acute exercise session will lead to an increase in health attitudes.

Hypothesis 1d. The completion of an acute exercise session will lead to an increase in physical activity attitudes.

Hypothesis 1e. The completion of an acute exercise session will lead to an increase in health-identity strength.

Hypothesis 1f. The completion of an acute exercise session will lead to an increase in health-goal commitment.

Hypothesis 1g. The completion of an acute exercise session will lead to an increase in in the perception that progress towards the individual's health goals has been made.

Hypothesis 1h. The completion of an acute exercise session will lead to a decrease in self-control resources.

Hypothesis 2a. Increased levels of health self-efficacy after completing an acute exercise session will lead to the selection of a healthy snack.

Hypothesis 2b. Increased levels of physical activity self-efficacy after completing an acute exercise session will not influence subsequent snack choice.

Hypothesis 2c. Increased levels of health attitudes after completing an acute exercise session will lead to the selection of a healthy snack.

Hypothesis 2d. Increased levels of physical activity attitudes after completing an acute exercise session will not influence subsequent snack choice.

Hypothesis 2e. Increased strength of health-identity after completing an acute exercise session will lead to the selection of a healthy snack.

Hypothesis 2f. Increased levels of health-goal commitment after completing an acute exercise session will lead to the selection of a healthy snack.

Hypothesis 2g. Increased perceptions that progress towards the individual's health goals has been made after completing an acute exercise session will lead to the selection of a healthy snack.

Hypothesis 2h. Decreased levels of self-control resources after completing an acute exercise session will lead to the selection of an unhealthy snack.

Method

The hypotheses and measures used in this study were pre-registered on the Open Science Framework (osf.io/a3q4v).

Design and Overview

A within-participants study design was used to examine changes in the psychological constructs that were proposed in the model from pre- to post-exercise in a

sample of exercisers and to investigate potential moderators. Because the psychological changes of interest were contingent on the participants' perception that they had completed an exercise session, participants were allowed to determine the mode, duration, and intensity of their exercise session as long as it met a minimum duration/intensity requirement (i.e., at least 30 minutes of moderate-intensity activity or at least 25 minutes of vigorous-intensity activity).

Power calculations using G*Power for testing the difference between two dependent means determined that a total of 209 participants would be needed to detect an effect size of 0.25 with 85% power at $\alpha = 0.00625$. A 0.25 effect size is considered to be a small effect (Cohen, 1988) and given the preliminary nature of this work, a small effect size was anticipated. Because multiple comparisons were necessary, the Bonferroni correction was used to control for the family-wise error rate, resulting in $\alpha = 0.00625$ (originally developed by Holm, 1979).

Participants

216 students at the University of Minnesota provided consent for this experiment. They were recruited through the University of Minnesota's Research Experience Program (REP) through which students can participate in psychology research experiments for extra-credit in their courses and through flyers that were posted around campus. To be eligible for participation, interested individuals indicated that they were over 18 years of age, were willing to complete an exercise session that met the American Heart Association's minimum recommendation for daily exercise (i.e., at least 30 minutes of moderate-intensity activity or at least 25 minutes of vigorous-intensity activity; 2015) at the University of Minnesota's Recreation and Wellness Center (hereafter referred to as

the "recreational center"), had a membership to access the recreational center, and were willing to complete surveys before and after their exercise session. Participants were compensated with either extra credit in their psychology classes or cash ($5 for every 30 minutes of participation).

Of the 216 individuals who provided initial consent for the experiment, 16 were excluded from the analyses for the following reasons: two pre- and post-exercise questionnaires could not be matched using the secret codes, three participants were missing more than half (i.e., > 4) of the entire psychological construct measures from either the pre- or post-exercise questionnaire, and 11 participants did not meet the minimum exercise requirement, leaving 200 participants for data analysis. The participants were 200 students (144 women, 52 men, 4 other) at the University of Minnesota, ranging in age from 18 to 74 years (M = 21.15, SD = 4.76). 76.5% reported that they were White/Caucasian, 4.0% were Black/African-American, 20.5% were Asian/Asian-American, 3.0% were Latino/Hispanic, 0.5% were Native American, and 1.5% identified as Other. 77.9% met the government's criteria for being a regular exerciser. Participants ranged in BMI from 16.46 to 38.6 kg/m^2 (M = 23.47, SD = 3.411).

Procedure

The procedure involved a short screening questionnaire, a pre-exercise questionnaire, a free-form acute exercise session of participants' choosing, a post-exercise questionnaire, and a snack choice.

Screening questionnaire. Interested participants from the REP pool were directed to an online screening questionnaire to assess interest and eligibility (see Appendix A). Of the participants who completed the screening questionnaire, 246

(55.5%) met the eligibility requirements and provided their contact information, 153 (34.5%) met the eligibility requirements but did not provide their contact information, one (0.2%) was under the age of 18, 12 (2.7%) were not willing to complete an exercise session at the recreational center, eight (1.8%) were not willing to complete an exercise session that met the minimum requirements, and 23 (5.2%) did not have a membership to the recreational center.

Participants who met the eligibility requirements were then invited to schedule an exercise session at the recreational center. They were told that they would be completing questionnaires both before and after exercise and to allot approximately 20 minutes before and 20 minutes after their exercise session to do so.

Pre-exercise questionnaire. Upon arrival for their scheduled exercise session, participants met with a research assistant and were asked to complete the online pre-exercise questionnaire that assessed each of the proposed psychological constructs (see Appendix B). The questionnaire measured health self-efficacy, physical activity self-efficacy, health attitudes, physical activity attitudes, health identity strength, health goal commitment, perceptions of progress towards health goals, and levels of self-control resources.

Acute exercise session. Participants then entered the recreational center and completed an acute exercise session of their choosing. They were allowed to select the mode (e.g., running on a treadmill, using a stationary bike, weight lifting), duration, and intensity of the exercise session as long as it was at least 30 minutes of moderate-intensity activity or at least 25 minutes of vigorous-intensity activity.

Post-exercise questionnaire. After exercising, participants returned to the research assistant's table and completed the online post-exercise questionnaire (see Appendix D). The questionnaire re-assessed each of the psychological constructs assessed in the pre-exercise questionnaire. The post-exercise questionnaire also included a short demographic questionnaire (see Appendix C) and questions about the exercise session that the participants just completed, such as the mode (e.g., treadmill, elliptical), duration, and perceived intensity.

Snack choice. Participants were then offered a snack, ostensibly as compensation for their participation in the study. The snack choices that were offered are the same as those that were offered by Fishbach and Dhar (2005): an apple (the healthy option) and a chocolate bar (the unhealthy option). Finally, participants were thanked for their time and given a debriefing form.

Measures and Materials

The materials and measures that were used in this study are described below. All of the measures were pilot tested before running the study.

Pilot testing. During pilot testing, 45 participants were recruited through Amazon's Mechanical Turk (MTurk) who were over the age of 18 and met the CDC's requirements for regular physical activity (i.e., they perform at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity exercise each week). Because the actual study consisted of an acute exercise session, regular exercisers were recruited for the pilot testing to ensure that the scores on the psychological measures would be representative of an active population. These participants completed the measures for health self-efficacy, physical activity self-efficacy, health attitudes, physical activity

attitudes, health identity, health goal commitment, health goal progress, and self-control resources in order to examine the relations between the measures.

Pilot testing of the psychological construct measures revealed that the affective health attitudes and affective physical activity attitudes were correlated very highly ($r > 0.85$). It was decided *a priori* that if any of the general and specific measures were correlated at or above $r = 0.70$ during the actual study, only the statistical analyses on the health measure would be conducted.

Health self-efficacy. To measure health self-efficacy, the Self-Rated Abilities for Health Practices Scale (Becker et al., 1993) was used. The Self-Rated Abilities for Health Practices Scale is a 28-item measure that asks participants to indicate the extent to which they feel as if they are able to complete a variety of health behaviors, ranging from "eat a balanced diet" to "brush my teeth regularly" to "find ways to exercise that I enjoy" on a scale ranging from 0 ("not at all") to 4 ("completely"). The scale has demonstrated sufficient reliability and validity through its relations with other measures of self-efficacy for various health behaviors (Callaghan, 2003) and was found to have excellent reliability both pre- ($\alpha = 0.91$) and post-exercise ($\alpha = 0.93$) in the present study.

Physical activity self-efficacy. The more specific construct of physical activity self-efficacy was measured using the 5-item Self-Efficacy for Exercise Behavior Scale (Marcus, Selby, Niaura, & Rossi, 1992). Participants used a 5-point Likert-scale ranging from 1 ("not at all confident") to 5 ("extremely confident") to rate their confidence that they could be physically active given various barriers (e.g., when they are tired or when it is raining or snowing). The scale has been shown to have adequate internal consistency (Marcus & Owen, 1992; Marcus et al., 1992), reliability (Mielenz, Edwards, & Callahan,

2011), and validity by explaining a significant amount of variance in actual physical activity behavior (Kubiak, 2004; Oliver & Cronon, 2002). Here, the scale was found to have acceptable internal consistency pre- ($\alpha = 0.74$) and post-exercise ($\alpha = 0.76$).

Health attitudes. Most studies examining attitudes related to health behaviors use an attitudinal measure that is specific to the health behavior of interest. Thus, in order to measure a broader attitude towards health behaviors in general, a measure was constructed combining the stem from a measure used to assess attitudes towards health-related behavior in general (Ajzen & Timko, 1986) with the scale from a physical activity-specific attitudinal measure (Rhodes, de Bruijn, & Matheson, 2010). Although Ajzen and Timko (1986) used 20 adjectives, in the present research, the same six bipolar adjectives that were used by Rhodes et al. (2010) were used to assess attitudes towards physical activity. The adjectives that Rhodes et al. (2010) selected came from Ajzen and Fishbein's (1980) suggestion that attitudes are comprised of both instrumental and affective components. To measure the instrumental component, the following bipolar adjective pairs were used: useful-useless, wise-unwise, and beneficial-harmful. To measure the affective component, the following bipolar adjective pairs were used: enjoyable-unenjoyable, pleasant-unpleasant, and exciting-boring. Here, the stem combines the reference to general health behaviors from Ajzen and Timko (1986) with the time frame of Rhodes et al. (2010) and says, "For me, performing generally recommended health practices over the next two weeks would be…". In the present study, the items measuring instrumental health attitudes had good reliability both pre- ($\alpha = 0.80$) and post-exercise ($\alpha = 0.84$). The items measuring affective health attitudes also had good internal consistency both pre- ($\alpha = 0.81$) and post-exercise ($\alpha = 0.83$).

Physical activity attitudes. Attitudes towards physical activity were measured using the same 7-point scale and six bipolar adjectives described above, but used the stem, "For me, regular physical activity over the next two weeks would be…", as was initially done in Rhodes et al. (2010). Both the instrumental and the affective measures were shown to have acceptable consistency (Rhodes et al., 2010). Here, the items measuring instrumental physical activity attitudes had good internal consistency both pre- ($\alpha = 0.87$) and post-exercise ($\alpha = 0.87$), as did the items measuring affective physical activity attitudes both pre- ($\alpha = 0.87$) and post-exercise ($\alpha = 0.86$).

Health identity. The measure of health identity was adapted from a previously used measure (Van der Werff et al., 2014) that was designed to measure environmental identity, that is, the extent to which the individual identified as someone who performs pro-environmental behaviors. The version that was adapted for this research was also a 3-item measure, and in the present modified version, the statements say, "Acting healthy is an important part of who I am;" "I am the type of person who does healthy behaviors;" and "I see myself as a healthy person." Participants were asked to rate the extent to which they agree with each statement on a 7-point Likert scale where 1 means "completely disagree" and 7 means "completely agree". The measure was found to have good internal consistency pre- ($\alpha = 0.87$) and post-exercise ($\alpha = 0.86$).

Health goal commitment. Participants used a 7-point Likert scale (1 = "not at all committed" to 7 = "extremely committed") to rate the level of commitment that they felt towards reaching their health goals. This approach is consistent with previous research examining goal commitment (e.g., Fishbach & Dhar, 2005). After pilot testing, it was

decided to make this measure more clearly a state measure by asking participants to rate how they felt "right now, that is, at the present moment."

Health goal progress. Using a measure of goal progress that was adapted from Brunstein's (1993) research, participants were asked to list up to three goals they had that were related to health (compared to the six goals requested by Brunstein). Participants were asked to evaluate progress in goal achievement in the recent past towards these three goals. For each of the three goals that they listed, they were asked to complete one two-item measure using a 7-point Likert scale ranging from 1 = "completely disagree" to 7 = "completely agree." The two-item measure was designed to assess goal advancement (e.g., "I have made a great deal of progress concerning this goal"). This measure was found to have good internal consistency both pre- ($\alpha = 0.81$) and post-exercise ($\alpha = 0.84$).

Self-control resources. To measure state levels of self-control resources, the short form of the State Self-Control Capacity Scale was used (Twenge, Muraven, & Tice, 2004). The State Self-Control Capacity Scale is a 10-item measure via which participants are asked to indicate the extent to which they agree with statements related to self-control, such as, "I feel drained" and "I feel like my willpower is gone" on a 7-point Likert scale ranging from 1 ("not true") to 7 ("very true"). Support for the scale's validity comes from significant decreases in state self-control following ego depleting laboratory manipulations (Twenge et al., 2004). Here, the scale was found to have good internal consistency pre- ($\alpha = 0.86$) and post-exercise ($\alpha = 0.86$).

Demographic information. Basic demographic information including age, gender, and race/ethnicity were assessed. Self-reported height and weight were measured so that body mass index (BMI) could be calculated.

Physical activity level. Baseline physical activity was measured during the post-exercise questionnaire using the short form of the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). The IPAQ asks participants to report on the number of days over the past week that they engaged in vigorous physical activity, moderate physical activity, walking, and sitting and then to indicate the total amount of time that they spent doing each activity. This short form IPAQ has been shown to have adequate validity (Craig et al., 2003).

Acute exercise session characteristics. Participants were asked three face-valid questions about the exercise session they had just completed. They listed the kind(s) of exercise(s) they did (e.g., ran on the treadmill, lifted weights) and how long they spent performing each exercise. Finally, they rated the intensity of their entire exercise session on a scale of 1 ("not at all intense") to 10 ("extremely intense").

Data Analysis Plan

First, the relations between the pre-exercise psychological variables and post-exercise psychological variables were examined to determine whether any were correlated highly enough that only the health variable should be used. Next, hypotheses 1a-1h that the psychological constructs would change from pre- to post-exercise were tested by performing dependent *t*-tests on each psychological variable. Because this required multiple comparisons, the Bonferroni correction was used to control for the family-wise error rate (originally developed by Holm, 1979). Using the Bonferroni

correction for 8 comparisons, $\alpha = 0.00625$. To compare the relative strength of each of the predictors, Cohen's *d* was calculated as a standardized effect size (Cohen, 1988). Then, to test hypotheses 2a-2h, first, the participants' snack choices were examined and, second, whether the changes in each of the psychological constructs predicted snack choice. Again, because this required multiple comparisons, the Bonferroni correction yielded $\alpha = 0.00625$. Finally, a series of exploratory analyses were conducted to investigate whether characteristics of the individual as a regular exerciser or not and characteristics of the exercise session itself moderated changes in the psychological variables. To protect against the multiple comparisons, again, the Bonferroni correction of $\alpha = 0.00625$ was used.

Results

Relations Between the Psychological Variables

Tables 1 and 2 present the correlations between each of the psychological construct variables pre- and post-exercise. Because the post-exercise instrumental health attitudes and instrumental physical activity attitudes were correlated very highly ($r = 0.83$) and the post-exercise affective health attitudes and affective physical activity attitudes were also correlated very highly ($r = 0.76$), only the measures of instrumental and affective health attitudes were used when running the rest of the analyses for Study 1.

Hypotheses 1a-1h: Testing Pre- to Post-Exercise Changes in the Psychological Variables

The performance of an acute exercise session led to a significant increase in all of the psychological constructs that were hypothesized to increase from pre- to post-exercise (i.e., health self-efficacy, physical activity self-efficacy, instrumental health attitudes,

affective health attitudes, health identity, health goal commitment, and health goal progress) as well as a significant increase in self-control resources from pre- to post-exercise that was in the opposite of the hypothesized direction (see Table 3 for statistics).

Two follow-up exploratory analyses were conducted to examine whether the type or specificity of the goals that participants listed affected perceptions of goal progress. Given the open-ended nature of the measure, there was large variability in the type and specificity of the goals that participants listed. Some participants listed broad health-related goals (e.g., "Exercise regularly"; "Get more sleep"), whereas other participants listed more specific health-related goals (e.g., "Run a 7:00 mile"; "Drink 4 bottles of water each day"). Furthermore, some of the goals were related to exercise specifically, whereas others pertained to other specific health behaviors. Goals were first coded as either exercise-related goals or non-exercise related goals. There were significant increases in perceptions of goal progress for both exercise-related goals and non-exercise related goals from pre- to post-exercise (see Table 4 for statistics). Next, the exercise-related goals about frequency of exercise were coded as either broad (e.g., "exercise regularly") or specific (e.g., "exercise 4 times per week"). There were significant increases in perceptions of goal progress from pre- to post-exercise for both broad exercise-frequency goals and for specific exercise-frequency goals (see Table 5 for statistics).

Hypotheses 2a-2h: Testing Whether the Changes in the Psychological Variables After Exercise Influenced Subsequent Snack Choice

Snack choice data was missing for six participants. Of the participants for whom there was data, 72.2% of participants chose the apple, 20.6% of the participants chose a

chocolate bar, 1.5% participants took both an apple and a chocolate bar, and 5.7% participants did not take either snack. It was decided *a priori* that only participants who selected *either* the apple or the chocolate bar would be included in the analysis.

Because snack choice is a dichotomous outcome (i.e., 0 = unhealthy snack; the chocolate bar, 1 = healthy snack; the apple), logistic regression was used (Hsieh, Bloch, & Larsen, 1998). To examine whether the changes in each of the psychological constructs predicted snack choice, multiple logistic regressions were conducted in which the change in each of the psychological constructs (i.e., the post-exercise – pre-exercise value of each construct) was entered as an individual predictor and snack choice was the outcome variable. None of the individual psychological construct variables (i.e., health self-efficacy, physical activity self-efficacy, instrumental health attitudes, affective health attitudes, health identity, health goal commitment, health goal progress, or self-control resources) were significant predictors of snack choice (see Table 6 for statistics).

A follow-up exploratory analysis was conducted to examine whether there was an effect of time of day such that participants were more likely to select the apple in the morning and the chocolate bar in the afternoon. The Qualtrics time stamp for the end of post-exercise questionnaire was used to approximate when each participant made her snack choice. In another study that controlled for time of day effects on snack choice (Incollingo Rodriguez, Finch, Buss, Guardino, & Tomiyama, 2015), the researchers coded the time of participation as morning, early afternoon, and late afternoon. Here, morning was coded as 8:00am-12:00pm, early afternoon was coded as 12:00pm-4:00pm, and late afternoon was coded as any time after 4:00pm. Time of day information was missing for 17 participants who completed the questionnaires on paper, and five of the

participants who completed the questionnaires on Qualtrics were excluded because they either chose both of the snacks or neither of the snacks. The proportion of participants who chose an apple was not found to differ significantly between whether they made their choice in the morning, the early afternoon, or the late afternoon ($\chi^2(2) = 2.52$, $p = 0.28$; see Table 7 for proportions).

Exploratory Analyses

Does status as a regular exerciser moderate the changes in the psychological variables? Using participants' responses to the IPAQ (Craig et al., 2003), they were classified as regular exercisers if they reported getting at least 150 minutes per week of moderate physical activity, at least 75 minutes per week of vigorous physical activity, or an equivalent mix of moderate and vigorous physical activity (e.g., at least 75 minutes per week of moderate physical activity and at least 37 minutes per week of vigorous physical activity; CDC, 2011). 155 participants were regular exercisers and 44 were not (data missing for 1 participant). To test for moderation, a mixed-model analysis of variance (ANOVA) was conducted for each of the psychological variables in which the within-subjects factor was time with two levels (pre-exercise and post-exercise level of each construct) and the between-subjects factor was whether or not participants were regular exercisers (see Table 8 for means). Whether the participant was a regular exerciser did not significantly moderate any differences in changes in physical activity self-efficacy, instrumental health attitudes, health identity, health goal commitment, health goal progress, or self-control resources, although there was a marginally significant difference in the pre- to post-exercise change for health self-efficacy and affective health attitudes (see Table 9 for statistics).

Does the type, duration, or intensity of the exercise session moderate the changes in the psychological variables?

Type of exercise. Type of exercise was categorized as cardiovascular training (N = 100), strength training (N = 17), or a mix of both cardiovascular and strength training (N = 83). To test for moderation of type of exercise, a 2 (time: pre- versus post-exercise) x 3 (type of exercise: cardiovascular versus strength versus mix of both) mixed model factorial analysis of variance (ANOVA) was conducted for each of the psychological constructs (see Table 10 for means). There were no significant differences in changes in health self-efficacy, physical activity self-efficacy, instrumental health attitudes, affective health attitudes, health identity, health goal commitment, health goal progress, or self-control resources depending on the type of exercise that the participant completed (see Table 11 for statistics).

Duration of exercise. Duration of exercise was the total number of minutes that participants reported exercising (see Table 12 for descriptive statistics). A regression analysis was conducted in which the change in each of the psychological variables (i.e., post-exercise minus pre-exercise) was the dependent variable and the duration of exercise in minutes was the predictor variable. The duration of the exercise that the participant completed was not a significant predictor of changes in health self-efficacy, physical activity self-efficacy, instrumental health attitudes, affective health attitudes, health identity, health goal commitment, or health goal progress. However, duration of exercise was a significant predictor of change in self-control resources such that a 1-minute increase in duration of exercise led to a .008 decrease in the change in self-control resources from pre- to post-exercise (see Table 13 for statistics).

A follow-up exploratory analysis tested whether there was a quadratic relation between duration of exercise and change in self-control resources. The addition of duration-squared to the model did not add significantly to the prediction of change in self-control resources, ($F(1, 197) = 0.28$, $p = 0.60$).

Intensity of exercise. Intensity of exercise was the participant's self-rated report on a 1-10 scale where 1 meant "not at all intense" and 10 meant "extremely intense" (see Table 12 for descriptive statistics). The correlation between intensity and duration was low ($r = .104$) and not significant ($p = .143$).

A regression analysis was conducted in which the change in each of the psychological variables (i.e., post-exercise minus pre-exercise) was the dependent variable and the self-reported intensity of the exercise session was the independent variable. The intensity of the exercise that the participant completed was not a significant predictor of changes in health self-efficacy, physical activity self-efficacy, instrumental health attitudes, affective health attitudes, health identity, health goal commitment, health goal progress, or self-control resources (see Table 14 for statistics).

Discussion

Drawing from the literature on behavioral spillover (Dolan & Galizzi, 2015; Thøgersen, 1999; Thøgersen & Ölander, 2003) and the lines of research on transfer cognitions (Barnett & Ceci, 2002) and on compensatory health beliefs (Knäuper et al., 2004; Rabiau et al., 2006), it was hypothesized that the performance of one health behavior would affect the subsequent performance of a different health behavior. The present paper put forward a novel model in which six psychological constructs were proposed as mechanisms by which this influence might occur: self-efficacy, attitudes,

health identity strength, health goal commitment, health goal progress, and self-control resources. The goal of the first study was to conduct a preliminary test of the model in a real-world environment and to determine whether the psychological constructs changed in the predicted ways in response to the completed performance of a single health behavior, specifically, an acute exercise session.

Changes in the Psychological Variables from Pre- to Post-Exercise

The results of Study 1 provided support for Hypotheses 1a-1c and Hypotheses 1e-1g; there were significant increases from pre- to post-exercise in health self-efficacy, physical activity self-efficacy, affective health attitudes, health identity, health goal commitment, and health goal progress, and a marginal increase from pre- to post-exercise in instrumental health attitudes. Hypothesis 1d was not tested due to the high correlation between health and physical activity attitudes. There was no support for hypothesis 1h, and in fact, the results supported the opposite pattern – that there was an increase in self-control resources from pre- to post-exercise.

Self-efficacy. Most previous research on behavior as a predictor of self-efficacy has found increases in behavior-specific self-efficacy in response to long-term interventions that target a specific behavior (e.g., Ashford et al., 2010; Hyde et al., 2008; Lewis et al., 2002). Although Grembowski et al. (1993) found evidence that health behavior-specific self-efficacy beliefs were related to one another, and Shelton (1990) posited that successfully performing a behavior would positively affect both general and behavior-specific self-efficacy, this study demonstrated that performing a single health behavior (i.e., an acute exercise session) led to an increase in overall health self-efficacy (i.e., Path A in Figure 1). Furthermore, there was also a significant increase in behavior-

specific physical activity self-efficacy from pre- to post-exercise, suggesting that just one successfully completed exercise session could affect confidence in one's ability to perform a behavior (i.e., Path B in Figure 1).

Although no prediction was made *a priori*, it might have been expected that the effect size for physical activity self-efficacy after an exercise session would be greater than that for health self-efficacy due to the principle of compatibility (i.e., that there will be greater agreement between an attitude and a behavior measured at the same level of specificity; Ajzen & Fishbein, 1977). In fact, the effect size for health self-efficacy was almost twice as large as the effect size for physical activity self-efficacy. Even when the exercise-related items on the health self-efficacy scale were separated from the non-exercise-related items, there was still a significant increase in self-efficacy for the other health behaviors.

This finding may have been due to the nature of the items in the scales that were selected. The health self-efficacy scale (the Self-Rated Abilities for Health Practices Scale; Becker et al., 1993) assessed people's confidence in their ability to perform various health behaviors, whereas the physical activity self-efficacy scale (the Self-Efficacy for Exercise Behavior scale; Marcus et al., 1992) assessed people's confidence in their ability to exercise in different situations, which may actually be tapping their *motivation* to exercise across various conditions. As Bandura (1977) posited through his performance accomplishments pathway by which people gain self-efficacy, successfully completing a single exercise session likely increased people's confidence that they would also be able to successfully perform other different health behaviors. However, the smaller increase in physical activity self-efficacy may also have been because the

exercise session was a scheduled appointment in which participants received compensation, which is atypical of an exercise session and therefore did not generalize as strongly to people's confidence that they could exercise in different, difficult situations. Taken together, these findings provide support for Paths A and B in Figure 1 that the performance of a single health-related behavior leads to increases in both health self-efficacy and behavior-specific self-efficacy, with a greater increase in health self-efficacy.

Attitudes. Supporting the idea that people construe their attitudes by observing their own behavior (Bem, 1972), there is evidence that patterns of behavior are predictive of people's attitudes towards that behavior (e.g., Hagger et al., 2001; McEachan, 2011). Study 1 demonstrated that even the performance of single health behavior led to significant increases in both how important performing health behaviors in general would be (i.e., instrumental health attitudes) and how enjoyable performing health behaviors in general would be (i.e., affective health attitudes; Path C in Figure 1).

Although the increase in affective health attitudes from pre- to post-exercise was significant, and the increase in instrumental health attitudes from pre- to post-exercise was marginally significant, both were small effects (Cohen's $d = 0.29$ and $d = 0.32$, respectively). For instrumental health attitudes especially, this may have been due to a ceiling effect such that people were already well-aware before the exercise session that performing generally recommended health practices is useful, wise, and beneficial, and therefore, there was little room for a change in instrumental health attitudes after exercising. In support of this idea, the pre-exercise mean for instrumental health attitudes was 6.41 on a 7-point Likert scale, and it increased to 6.55 post-exercise. Furthermore,

although after completing an exercise session, people may have felt that exercise itself was more enjoyable, the small increase in affective health attitudes may have been because this feeling did not generalize to other health practices (e.g., eating fruits and vegetables) as strongly.

Health identity. Also consistent with Bem's self-perception theory (1972), there is evidence that people use observations of their past behavior to inform their behavior-relevant identity (e.g., Lee et al., 1999; Van der Werff et al., 2014; Vangeli & West, 2012). These studies suggest that past patterns of behavior lead to increases in behavior-relevant identity. However, in the present study, participants were not asked to reflect on multiple instances in which they may have performed a behavior. Instead, they completed a single, specific health behavior – an acute exercise session. The successful performance of this health behavior may have helped to activate and strengthen participants' identities as people who do health behaviors in general, thereby making their health identity particularly salient and accessible in their minds during the post-exercise questionnaire (Markus & Wurf, 1987; Stryker, 1968). In fact, it was demonstrated that a performance of one specific health behavior (i.e., an acute exercise session) led to a significant increase of a small-to-medium effect size in health identity, or the belief that one is the type of person who does health behaviors in general (i.e., Path E in Figure 1). In this way, if a single exercise session leads to a significant increase in an individual's perception that she is a healthy individual, then it is likely that with regular exercise, the individual's health identity would become strengthened and solidified over time.

Health goal commitment. Similarly, the perception that one has successfully performed a single behavior is thought to contribute to an individual's level of

commitment towards a broader goal (e.g., Bem, 1972; Soman & Cheema, 2004). Given that the participants in Study 1 completed an exercise session, it was assumed that they would perceive that as the successful performance of a health behavior. On average, there was a significant increase of a small-to-medium effect size in self-reported commitment to health goals from pre- to post-exercise, suggesting that this perception did in fact lead to increased commitment to health-relevant goals (i.e., Path F in Figure 1).

Given that potential participants were aware that an exercise session was a requirement for this study, it is likely that they were already highly committed to their health goals even before signing up. In fact, the pre-exercise single-item measure of health goal commitment was negatively skewed. Therefore, although many of the participants in this study were already highly committed to achieving their health goals, a complete exercise session was sufficient to lead to a moderate increase in overall health goal commitment.

Health goal progress. Past research suggests that successfully completing a sub-goal within a broader-level goal should indicate that progress has been made towards that goal (Brunstein, 1993; Cantor & Kihlstrom, 1987). In the current study, the idea was that the successful completion of an acute exercise session would lead to the perception that progress had been made towards achieving one's health goals. On average, there was a significant increase in perceived progress towards health-related goals from pre- to post-exercise (i.e., path G in Figure 1), although it was among the smaller effects (Cohen's d = 0.35).

In the present study, participants were asked to list up to three goals that they had related to heath and their perceived progress towards those goals both before and after an

exercise session. Due to the open-ended nature of the measure, there was large variability in the type and specificity of the goals that participants listed. In follow-up analyses, the idea that the type and specificity of the goals listed differentially influenced perceptions of progress was tested. Although someone who listed goals that were specific to health behaviors other than physical activity may not have perceived a completed exercise session as making progress towards their other health-related goals, the results suggested that regardless of the type of goal listed by participants, there were still increases in perceptions of progress towards non-exercise-related goals from pre- to post-exercise. Furthermore, participants who listed broad exercise goals (e.g., "Exercise 3 times per week") might have been more likely to report increases in goal progress because a completed acute exercise session served as a discrete progress marker indicating that the individual was one step closer to achieving their goal (Amir & Ariely, 2008). However, this idea was not supported because there were significant increases in goal progress regardless of whether the exercise-frequency goal was broad or specific. Taken together, the successful completion of one exercise session led to increases in perceptions of health goal progress regardless of the type or specificity of the health goal listed. This could be why, on average, there was an increase of a small effect size in perceptions of goal progress from pre- to post-exercise.

Self-control resources. The strength model of self-control posits that when an individual exerts self-control to perform one behavior, it reduces the amount of self-control that she has left to perform a later behavior (Baumeister et al., 1998; Muraven & Baumeister, 2000). Although recent, albeit disputed, meta-analytic evidence suggests that self-control resource depletion might be a null effect (Carter et al., 2015; Hagger et al.,

2015), the prediction that the performance of an acute exercise session would require self-control and therefore, would lead to a perceived decrease in self-control resources was tested. However, in the present study, there was not only a significant increase in self-control resources from pre- to post-exercise (i.e., Path H in Figure 1), but this increase had the largest effect size of any of the psychological constructs. This increase in self-control resources is nevertheless consistent with a finding from the smoking cessation literature in which participants who had exercised self-control by successfully resisting a temptation to smoke demonstrated increased self-control as operationalized by fewer lapses in smoking later on (O'Connell, Schwartz, & Shiffman, 2008).

It is possible that the nature of the health behavior used in the present study may explain the discrepant prediction. In previous research on self-control depletion in health psychology using the sequential task paradigm, researchers asked participants to engage in a health behavior that required continuously overriding one's impulses to indulge in order to induce self-control resource depletion. In one study, researchers presented participants with tasty foods and asked them to sit in the presence of these foods without eating them, thereby having to constantly override any desires to do so (Hagger et al., 2009). In another study, participants were instructed to eat unappetizing foods like radishes while in the presence of appetizing foods like cookies (Baumeister et al., 1998), and finally, in one study, social drinkers were asked to sniff alcohol and then were not given a drink (Muraven & Schmueli, 2006). In the present study, physically active participants were asked to complete an exercise session. Although it is possible that throughout the exercise session, participants may have had to continuously override a desire to stop exercising, it is not obvious that this occurred. Instead, it is possible that

this completion of the exercise session did not require continuously overriding one's impulses in the same way, and so the exercise session was perceived as a success and therefore was rejuvenating, not depleting in the way that overriding one's impulses to eat an indulgent food or drink alcohol may be. Furthermore, the completion of an exercise session may be viewed more as a successful accomplishment than would be completing an idiosyncratic task that had been assigned by a researcher.

Another key difference between past studies and the present study is the outcome measure. In the majority of past research on self-control, researchers used performance on a subsequent self-control task that was in a different domain from the original depleting task, such as the amount of time participants spent working on unsolvable puzzle as an indicator of self-control resources (e.g., Baumeister et al., 1998; Muraven et al., 1998). In the present research, a self-report measure of state self-control resources was used. Although it may have been erroneous to assume that participants were able to accurately reflect on and report their levels of self-control, it is possible that after exercising and when asked to consciously reflect on their levels of self-control broadly, participants may have seen themselves as successfully demonstrating self-control, and so, due to self-perception (Bem, 1972), they reported having higher self-control resources after exercise than they did before.

Furthermore, unlike past research in which the outcome measure of self-control was completed almost immediately after the depleting task, there was a greater lag between the two in the present study. Although the measurement of self-control was done as soon after exercising as possible, there was inevitably a delay between the moment that the participants stopped exercising and when they returned to the lobby of the

recreational center to complete the questionnaire. This lag may have given them additional time to reflect on the fact that they had exercised self-control in completing their exercise session, which was subsequently reflected in the self-reported measure that was used. In sum, the direction and the size of the change in self-control resources may have been counter to my initial prediction because of a number of differences between past research on depletion and the present study including how completing an exercise session may have been perceived as more of an accomplishment than how resisting one's impulses during an arbitrary laboratory task is perceived, the self-report outcome measure, and the time lag between the depleting task and the outcome measure of self-control.

Snack Choice

The secondary goal of Study 1 was to examine whether these psychological changes influenced a second health behavior – subsequent snack choice (i.e., eating behavior). Although all but one of the psychological constructs significantly changed in the anticipated direction, there was no evidence that any of these changes predicted a choice between a healthy snack (i.e., an apple) and an unhealthy snack (i.e., a chocolate bar) after exercise. In fact, the majority (77.8%) of participants selected an apple, and there was no evidence for a time of day effect such that participants were more likely to take the fruit in the morning than in the early or late afternoon. Although the snack choice was presented ostensibly as additional compensation for participation and the research assistants were trained to use the lid of the box that the snacks were in as a barrier to create a sense that the snack choice was private, it is still possible that demand characteristics, specifically self-presentational concerns were at play. It has been well-

documented in the literature that people's eating behavior is easily influenced by concerns about how others will perceive them (e.g., Herman, Roth, & Polivy, 2003; Mori, Chaiken, & Pliner, 1987; Pliner & Chaiken, 1990; Roth, Herman, Polivy, & Pliner, 2001). Therefore, it is possible the majority of participants felt these self-presentational concerns and felt as if they should take a healthy snack after exercising or because they were in front of a research assistant and knew that they were participating in a study on at least one health behavior – exercise.

Characteristics of the Exerciser and the Exercise Session

Study 1 was limited in that it was a naturalistic study in which changes in the psychological constructs were observed after participants completed an exercise session of their choosing. Thus, there was no experimental control over the type, duration, or intensity of exercise that they completed. However, this variability was used to understand whether the characteristics of the exercise session moderated the observed changes in the psychological constructs. Additionally, moderation of the changes in the psychological constructs by whether the individual was a regular exerciser or not was examined.

Regularity of exercise. Although regularity of exercise did not significantly moderate changes in most of the psychological constructs from pre- to post-exercise (i.e., physical activity self-efficacy, instrumental health attitudes, health identity, health goal commitment, health goal progress, and self-control resources), there were marginally significant interactions for health self-efficacy and for affective health attitudes such that non-regular exercisers showed slightly greater increases in these two psychological constructs from pre- to post-exercise.

Initially, there was a slight difference between regular exercisers and non-regular exercisers in health self-efficacy. Therefore, it is possible that because these individuals do not exercise on a regular basis, successfully performing just one exercise session for this study could have led to a slightly more extreme increase in their efficacy for exercise and other health behaviors (Bandura, 1977) than for regular exercisers because the behavior itself was atypical for them.

Similarly, non-regular exercisers had lower affective attitudes towards physical activity at baseline compared to regular exercisers. This suggests that because they were not normal exercisers, they initially perceived exercise to be less enjoyable or pleasant than did the regular exercisers. However, after exercising, they may have realized that it was more enjoyable, pleasant, and exciting than they had anticipated, thus leading to the greater increase in affective attitudes. Given that affective attitudes and anticipated affective reactions have been shown to be strong predictors of both intentions to do health behaviors and the performance of health behaviors (Conner, McEachan, Taylor, O'Hara, & Lawton, 2015; Lawton, Conner, & McEachan, 2009; Lawton, Conner, & Parker, 2007), demonstrating that a single exercise session can lead to a more intense increase in affective attitudes for non-regular exercisers suggests that getting non-regular exercisers to complete an exercise session may be an important step in improving their affective attitudes towards exercise, which may ultimately lead to increases in intentions to exercise and overall exercise behavior.

Type of exercise. The type of exercise session that participants completed (i.e., cardiovascular, strength training, or some combination of the two) was not a significant predictor of changes in any of the psychological constructs, meaning that the changes

were not more or less extreme based on the nature of the exercise. This suggests that the changes in the psychological constructs are likely not due to the idiosyncratic characteristics of the exercise session and may instead be caused by the overall perception that an exercise session has been completed, regardless of the type of exercise. However, this finding should be interpreted with caution due to the small number (N = 17) of individuals who only completed a strength training session. The majority of participants completed either a cardiovascular-only exercise session or an exercise session that consisted of both cardiovascular and strength training, and so there may be something about cardiovascular exercise in particular that leads to the perception that one has successfully done an acute exercise session.

Duration of exercise. Duration of exercise was a significant predictor of changes in only one of the psychological constructs, change in self-control resources, such that spending more time exercising led to a decrease in the amount of change in self-control resources from pre- to post-exercise. On average, there was actually an increase from pre- to post-exercise in self-control resources, so this suggests that it may require greater self-control to exercise for a longer duration, meaning that the increase in self-control resources gets smaller the longer someone exercises.

Intensity of exercise. Participants' self-reported intensity of their exercise session was unrelated to the duration of the exercise session and was not a significant predictor of changes in any of the psychological constructs, meaning that the changes were not more or less extreme based on how intensely individuals exercised. This provides further support for the idea that the changes in the psychological constructs may be due to the

perception that someone has completed a health behavior like exercise and not due to the idiosyncratic characteristics of the exercise session.

Conclusion

In summary, Study 1 was a successful preliminary test of the efficacy of the model in a naturalistic environment. All but one of the psychological constructs (i.e., self-control resources) changed in the predicted ways in response to the completion of an exercise session of the participants' choosing. However, there are several limitations to consider. For one, administering the questionnaire immediately before the exercise session may have led to a demand effect in which participants responded more positively on the health-related measures. Furthermore, by using a repeated-measures design in which participants responded to the same questionnaire after the exercise session as they did before it, they may have made some assumptions about the hypotheses of the study and therefore, responded in a more positive way on the health-related measures in order to be a "good subject" (Nichols & Maner, 2008).

Although none of the changes in the psychological constructs significantly predicted participants' snack choice between a healthy and an unhealthy snack, it is possible that this null effect was due to demand characteristics, specifically self-presentational concerns (e.g., Herman et al., 2003; Mori et al., 1987; Pliner & Chaiken, 1990; Roth et al., 2001). To reduce the possibility of demand characteristics in Study 2, participants will be asked to complete a food diary of what they eat in the privacy of their own homes after they leave the laboratory. Furthermore, eating behavior will be measured in a broader way than a dichotomous choice between two foods. Instead, eating behavior will be evaluated more holistically, by examining servings of fruits and

vegetables consumed, percentage of total calories from fat, percentage of total calories from sugar, the number of indulgent foods consumed, and the number of self-licensed foods consumed (i.e., foods that they would not have otherwise if they had not exercised). It is possible that the strongest differences in eating outcomes will be for the number of servings of fruits and vegetables, the number of indulgent foods consumed, and the number of self-licensed foods consumed and that the differences between groups in percentage of calories from fat and sugar might be subtler. This is because the consumption of certain healthy foods like healthy oils and nuts might increase the percentage of calories from fat, while the consumption of fruits might increase the percentage of calories from sugar.

Finally, for the most part, none of the characteristics of the exercise session (i.e., the mode, duration, or intensity) moderated the changes in any of the psychological variables, which supports the idea that these changes may be due to the perception that an exercise session has been completed and not due to idiosyncratic characteristics of the exercise session itself. Therefore, in Study 2, it will be key to portray to participants that 30 minutes of bicycling at moderate-intensity constitutes an exercise session. Although a longer duration of exercise led to a decrease in the change in self-control resources, this will be controlled for in Study 2 in that all participants will complete a moderate-intensity exercise session for 30 minutes.

Study 2 will build on Study 1 by examining whether an experimental manipulation of the psychological constructs can alter the effect of an acute exercise session on subsequent eating behavior. The psychological constructs that are put forward by the model can be divided into those that should lead to healthy eating (i.e., a

promotion spillover) and those that should lead to unhealthy eating behavior (i.e., a permitting spillover). A promotion spillover may occur through increased health self-efficacy (e.g., Becker et al., 1989), health attitudes (Sheeran et al., 2016), health identity strength (e.g., Van der Werff et al., 2014), and health goal commitment (e.g., Fishbach & Dhar, 2005; Soman & Cheema, 2004), whereas a permitting spillover may occur through increased perceptions of health goal progress (Brunstein, 1993; Fishbach & Dhar, 2005) and decreases in self-control resources (Baumeister et al., 1998; Vohs & Heatherton, 2000). Although in Study 1, there was a significant increase in self-control resources after the exercise session, it is possible that in Study 2, the laboratory exercise session will be more depleting and will be perceived as less of a personal accomplishment than the naturalistic exercise was because the researcher will control the mode, duration, and intensity of the exercise session. Therefore, the initial prediction that exposure to a permitting spillover manipulation prior to a controlled laboratory exercise session may affect eating through decreased self-control resources will remain.

Study 2 will differentially manipulate whether participants perceive a controlled laboratory exercise session as a behavior that should lead to other health behaviors (i.e., a promotion spillover) or as a behavior that should lead to other unhealthy behaviors (i.e., a permitting spillover) and then examine whether the psychological variables mediate the relation between the exercise session and subsequent eating behavior throughout the remainder of the day.

Study 2: Experimental Test of Mediation of the Relation Between Acute Exercise and Subsequent Eating Behavior

Study Design and Overview

The second study was designed to examine whether the psychological constructs mediated the relation between an acute exercise session and subsequent eating behavior. The psychological constructs that were put forward by the model can be divided into those that should lead to healthy eating (i.e., a promotion spillover) and those that should lead to unhealthy eating behavior (i.e., a permitting spillover). Similar to the findings that transfer cognitions were positively related to behavioral intentions and self-regulatory strategies and that compensatory health beliefs were negatively related to behavioral intentions and self-regulatory strategies (Fleig et al., 2015), it seems as though the mediators for which exercise should lead to healthy eating are those that involve the perception of exercise as a behavior that serves to further one's health goals broadly, whereas the mediators for which exercise should lead to unhealthy eating are those for which exercise is perceived as a means to an end. In this way, when completing an exercise session is perceived as effortful and as leading towards progress towards a specific goal, people may choose to later reward themselves with indulgent foods. However, when people perceive that the completion of an exercise session will lead to improved health, people may be more inclined to make eating decisions that are consistent with furthering their overall health.

In the second study, participants were randomly assigned to one of three conditions: (1) a promotion spillover manipulation in which exercise was presented as a behavior that could contribute to people's overall health and discussed how the strategies used to perform an exercise session could be applied to other health behaviors, (2) a permitting spillover manipulation in which exercise was presented as a behavior that would allow people to self-license (i.e., to eat unhealthy foods), or (3) a control condition

in which they did not exercise or think about exercise in any particular way. Participants in the exercise manipulation conditions completed a 30-minute exercise session, and participants in the control condition watched non-exercise related cartoons for 34 minutes, after which the psychological constructs from the proposed models were assessed.

Participants were then asked to record their eating behavior throughout the remainder of the day to test whether the changes in the psychological constructs mediated the relationship between the exercise session and subsequent eating behavior. The dependent variable of eating behavior was operationalized in five different ways. The first three ways emphasized healthy eating behavior: (1) the number of servings of fruits and vegetables that were consumed during the day (Krebs-Smith & Kantor, 2001), (2) the percentage of total calories from fat that was consumed during the day (Dixon & Ernst, 2001), and (3) the percentage of total calories consumed from sugar that was consumed during the day (World Health Organization, 2015). The other two dependent measures were indicators of self-licensing (de Witt Huberts et al., 2012): (4) the number of indulgent foods participants consumed and (5) the number of foods participants reported that they ate but would not have had they not participated in one of the two laboratory activities (i.e., exercise or cartoon-watching)[1]. The following hypotheses were specified:

Hypothesis 3a. Participants who are exposed to the promotion spillover manipulation and then complete a 30-minute exercise session will consume more

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[1] Although the pre-registered hypotheses would have examined whether or not participants had consumed an indulgent food and/or had engaged in self-licensing, the final analyses used the continuous variable of the number of indulgent or self-licensed foods consumed because there would be greater variability in responses.

servings of fruits and vegetables throughout the remainder of the day than will participants who are exposed to the permitting spillover manipulation and than will participants in the control condition. This effect will be mediated by increases in health self-efficacy, health attitudes, health identity, and health goal commitment. Increases in physical activity self-efficacy and physical activity attitudes after exercise are not predicted to mediate this effect due to the principle of compatibility (Ajzen & Fishbein, 1997).

Hypothesis 3b. Participants who are exposed to the promotion spillover manipulation and then complete a 30-minute exercise session will consume a smaller percentage of calories from fat throughout the remainder of the day than will participants who are exposed to the permitting spillover manipulation and than will participants in the control condition. This effect will be mediated by increases in health self-efficacy, health attitudes, health identity, and health goal commitment. Increases in physical activity self-efficacy and physical activity attitudes after exercise are not predicted to mediate this effect due to the principle of compatibility (Ajzen & Fishbein, 1997).

Hypothesis 3c. Participants who are exposed to the promotion spillover manipulation and then complete a 30-minute exercise session will consume a smaller percentage of calories from sugar throughout the remainder of the day than will participants who are exposed to the permitting spillover manipulation and than will participants in the control condition. This effect will be mediated by increases in health self-efficacy, health attitudes, health identity, and health goal commitment. Increases in physical activity self-efficacy and physical activity attitudes after exercise are not

predicted to mediate this effect due to the principle of compatibility (Ajzen & Fishbein, 1997).

Hypothesis 3d. Participants who are exposed to the permitting spillover manipulation and then complete a 30-minute exercise session will eat more indulgent foods during the remainder of the day than will participants who are exposed to the promotion spillover manipulation and than will participants in the control condition. This effect will be mediated by increases in perceptions of goal progress and decreases in self-control resources.

Hypothesis 3e. Participants who are exposed to the permitting spillover manipulation and then complete a 30-minute exercise session will be more likely to report that they have engaged in self-licensing during the remainder of the day by eating a great number of foods than they would have if they had not participated in the laboratory activity than will participants who are exposed to the promotion spillover manipulation and than will participants in the control condition. This effect will be mediated by increases in perceptions of goal progress and decreases in self-control resources.

Method

The hypotheses and measures used in this study were pre-registered on the Open Science Framework (osf.io/pkzrg).

Design and Overview

A between-participants experimental design was used to examine whether manipulating how individuals think about an acute exercise session influenced subsequent eating behavior throughout the remainder of the day compared to a control

condition in which participants did not exercise and were not exposed to any manipulation changing how they think about exercise.

Power calculations determined that a total of 180 participants would be needed to detect an effect size of 0.25 with 85% power for the main effect of experimental condition on eating behavior. A 0.25 effect size is considered to be a small effect (Cohen, 1988) and was selected because of the preliminary nature of this work and the naturalistic nature of the eating portion of the study.

Participants

209 students at the University of Minnesota provided consent for this experiment. They were recruited through the University of Minnesota's Research Experience Program (REP) and through flyers that were posted around campus. To be eligible for participation, interested individuals indicated that they were over 18 years of age, they had not participated in Study 1, and that they were willing and able to complete a moderate 30-minute exercise session in the laboratory.

Of the 209 individuals who provided initial consent for the experiment, 14 were excluded because they did not send in a food log after their date of participation and four were excluded because they either recorded additional exercise in their food logs or indicated to a research assistant that they were planning to exercise again later that day, leaving 191 participants for data analysis. The participants were 191 students (142 women, 48 men, 1 other), ranging in age from 18 to 53 years ($M = 21.16$, $SD = 4.39$). When the participant identifying as "other" was removed, gender was not evenly distributed across the three conditions, such that the control condition had a higher proportion of women (85%) compared to the promotion (65%) and permitting conditions

(71%; $X^2(2) = 8.28$, $p = .016$). 72.3% reported that they were White/Caucasian, 7.9% were Black/African-American, 21.5% were Asian/Asian-American, 2.6% were Latino/Hispanic, 0.5% were Native American, and 2.6% identified as Other. 64.9% met the government's criteria for being a regular exerciser, and regular exercisers were evenly distributed across condition ($X^2(2) = 1.17$, $p = .56$). Participants ranged in BMI from 16.98 to 46.0 kg/m^2 ($M = 23.54$, $SD = 4.48$; 5 unintelligible responses were deleted from this analysis), and BMI was evenly distributed across condition, ($F(2, 183) = .61$, $p = .54$).

Procedure

The procedure involved a screening questionnaire, a laboratory session that included a 30-minute moderate exercise session with a warm-up or a 34-minute sedentary control session, a post-activity questionnaire, and a brief training session for a food diary, and then the completion of a food diary throughout the remainder of the day.

Screening questionnaire. Potential participants were asked to complete a short online questionnaire to assess interest and eligibility (see Appendix E). The screening questionnaire included a number of filler questions about potential activities that participants might have been asked to do in the laboratory (e.g., drink alcohol, sample vegan foods, etc.), but participants were only eligible if they indicated that they would be interested in participating in a 30-minute exercise session in the laboratory, had not participated in Study 1, and were over the age of 18.

Laboratory session. All individuals who were eligible for participation were invited to schedule a 1-hour morning laboratory session between 8:00 am and 12:00 noon. Participants were randomly assigned to a condition prior to coming into the

laboratory, and the participants who were assigned to one of the exercise conditions were asked to wear gym clothes and sneakers to the laboratory. All participants were asked to refrain from exercise before coming to the laboratory and not to eat for two hours prior to their session in order keep the sessions standardized. When participants arrived at the laboratory, they were exposed to the promotion spillover or the permitting spillover manipulation or received instructions about the control sedentary session.

Acute exercise session. Participants in the two exercise conditions were asked to complete a short warm-up followed by a 30-minute exercise session. The protocol for the exercise session is described below in the Measures and Materials subsection.

Control sedentary session. Participants in the control sedentary condition were asked to rest quietly in a comfortable chair while watching 34-minutes of cartoons. Theoretically, there is no reason to believe that watching cartoons should influence any of the psychological constructs proposed by the model. Furthermore, watching cartoons has been used as a control condition when examining the effects of vigorous exercise on the cognitive construct of inhibitory control (Browne et al., 2016).

Post-exercise questionnaire. After completing either the acute exercise sessions or the control sedentary relaxation session, participants completed a post-exercise questionnaire that included measures designed to assess each of the proposed psychological mediators from the model: health self-efficacy, physical activity self-efficacy, attitudes towards health behaviors, attitudes towards physical activity, health identity strength, commitment towards health goals, perceptions of progress towards health goals, and levels of self-control resources (see Appendix B). The post-exercise questionnaire also included a few short demographic questions.

Food diary training session. A research assistant then worked with each participant to set up an account for Lose it! that could be accessed through the Internet. The Lose It! application received an "Excellent" rating for its nutritional database in an evaluation of mobile nutrition tracking applications (Darby, Strum, Holmes, & Gatwood, 2016). During the training session, the participants were given instructions on the type of profile to create – they were asked to allot themselves 4,000 calories per day, and the research assistant emphasized that this was not to be treated as a dieting application, but as a food log. Participants were instructed to track all food that they ate during the remainder of the day of participation, such as lunch, dinner, and any snacks, including alcoholic beverages, and to complete the food diary immediately after each meal.

Additional instructions. All participants were asked not to complete another acute exercise session (defined as a time in which they sought physical activity, *excluding* walking or biking for transportation) that day so as to keep the days standardized across participants.

Follow-up e-mails. The next morning, all participants received a follow-up e-mail with instructions on how to download their food log and send it to the research team. The e-mail also included a short follow-up questionnaire (see Appendix G). After participants submitted their completed food log, they received a debriefing form in a later e-mail. If participants did not submit their completed food log within one week or after receiving two reminder e-mails, they were e-mailed the debriefing form.

Measures and Materials

The materials and measures that were used in this study are described below. All of the measures were pilot tested before running the study.

Psychological variable measures. For the post-exercise questionnaire, the same measures that were used to assess the psychological constructs in Study 1 were also used in Study 2, with one modification. Due to the unanticipated increase in self-control from pre- to post-exercise, one item from the full 25-item State Self-Control Scale ("I am having a hard time controlling my urges"; Twenge et al., 2004) was added to the State Self-Control Capacity Scale to further tap self-licensing. Like in Study 1, each of the measures demonstrated good to excellent reliability (see Table 15 for Cronbach's alphas).

Pre-exercise video manipulations. The promotion spillover and permitting spillover manipulations were two short videos that last three and a half minutes. The promotion spillover video presented exercise as a behavior that when performed regularly can contribute to people's overall health, and the video also discussed how the strategies used to implement an exercise session could be applied to other health behaviors. The permitting spillover manipulation presented exercise as a behavior that allows people to self-license and provides justification for doing other unhealthy behaviors.

The video manipulations were created and pilot tested to ensure that the message was clear to participants and that they were similar on constructs that might have potentially confounded the results, such as how interesting and engaging they were and the strength and logic of the arguments presented. In each of three pilot studies, participants were randomly assigned to watch one of the videos and then rated these constructs using 5-point Likert scales from 1 ("very uninteresting/unengaging/weak/illogical") to 5 ("very interesting/engaging/strong/logical"). Participants were also asked to articulate the main

message of the video and whether they had suggestions for how to make the message clearer.

During the first round of pilot testing (n = 10 undergraduates, 5 graduate students; 4 men, 11 women), there were no differences between conditions on any of the measured constructs. The responses to the open-ended questions were used to improve the videos by making some of the dialogue clearer and simpler. Additionally, the initial videos only included text about the benefits of exercise, so in order to help convey and emphasize the main messages, text was added describing either the applicability of the strategies used for exercise to other health behaviors or the ways in which exercise allows individuals to self-license.

To ensure that these modifications helped with understanding the main message of the videos, a second round of in-person pilot testing was conducted (n = 7 undergraduates, 2 graduate students, 1 other; 4 men, 6 women). There were again no differences on the measured constructs. All of the participants who viewed the promotion video and 4/5 of the participants who viewed the permitting video were able to verbalize the main message.

Finally, the third round of pilot testing was conducted primarily to test, first, whether the videos differed on the cognitive measures with sufficient power, and second, to confirm that viewers were able to articulate the videos' messages. Participants were recruited through Amazon's Mechanical Turk (n = 71; 49 men, 22 women). There were no differences in how interesting or engaging the two videos were, but the arguments were perceived to be stronger and more logical in the promotion condition than in the permitting condition. 19/39 participants articulated the main message of the promotion

video; those who did not tended to focus on either how exercise is important and has health benefits or that exercising is effortful, but worthwhile. 18/32 participants articulated the main message of the permitting video; those who did not tended to focus on either the health benefits of exercise or that exercising can improve quality of life.

Acute exercise session. During the exercise session, the participant exercised on a spinner bike for 30 minutes. Using the same protocol for a moderate-intensity exercise session on a stationary bicycle that was used by Hogan, Mata, and Cartensen (2013), participants had time to warm up and increase their heart rate to 50% heart rate reserve (HRR; Karvonen, Kentala, & Mustala, 1957). Once the participants reached 50% HRR, the 30-minute exercise session began. Heart rate reserve is defined as the difference between resting heart rate and maximum heart rate, where maximum heart rate is 220 minus the individual's age (American Heart Association, 2016). The American College of Sports Medicine (2009) defines moderate-intensity exercise as 40-60% of a person's HRR, so trained research assistants monitored the participant's heart rates throughout the exercise session. If their heart rate fell below 40% HRR, they were asked to increase the pace or resistance, and if their heart rate went above 60% HRR, they were asked to slow down the pace or take off resistance from the bicycle.

Control sedentary session. Participants in the control sedentary condition were told that they would be watching a movie for approximately half an hour. The movie consisted of cartoon film clips from the SpongeBob Squarepants show. To understand whether watching cartoons would elicit a different affective reaction than would an exercise session, in pilot testing, 40 participants (10 men, 30 women) either watched the cartoon (n = 19) or completed the moderate-intensity exercise session (n = 21) and then

completed the Four-Dimension Mood Scale (4DMS; see Appendix F; Huelsman, Nemanick, & Munz, 1998; Gregg & Shepherd, 2009) to ensure that any affective changes would be similar. Although there were no between-condition differences in levels of relaxation or negative arousal between conditions, participants who exercised had higher levels of positive energy, whereas participants in the cartoon condition reported being slightly more tired.

Heart rate. Participants' heart rate was recorded using a Polar H7 heart rate monitor.

Food diary. In order to track the food that participants ate, they were trained on how to use LoseIt! and were e-mailed instructions on how to send a copy of the food log to the research team. Only lunch, dinner, and snacks were included in the analyses; if participants categorized any foods as breakfast, those foods were removed. Because LoseIt! is an online food database, some of the food entries were incomplete and included n/a in the nutrient composition reports. When that was the case, either the serving size or the number of calories for the food were used and supplemental nutrient information was found using the MyFitnessPal application.

Fruit and vegetable consumption. First, a list of fruits and vegetables and their normal serving size was compiled (see Appendix G) using the guidelines provided on the United States Department of Agriculture (USDA)'s ChooseMyPlate website (2018b). One vegetable serving consisted of 1 cup of a raw or cooked vegetable (including non-fried potatoes), 2 cups of raw leafy greens, or a ½ cup of cooked beans (Greenwood, 2017). One fruit serving consisted of 1 cup of fruit, the first 8 oz of 100% fruit juice for the day, or ½ cup of dried fruit (USDA, 2018a; see Table 16 for descriptive statistics).

Percentage of calories consumed from fat and sugar. The LoseIt! food logs included the number of grams of fat, the number of grams of sugar, and the number of calories in each food. The total calories, grams of fat, and grams of sugar for the day were calculated by taking the sum of each for all of the foods consumed. To calculate the percentage of calories consumed from fat (sugar), the total number of grams of fat (sugar) were multiplied by nine (four) because there are nine (four) calories in one gram of fat (sugar) (USDA, n.d.), and then this number of calories consumed from fat (sugar) was divided by the total number of calories (see Table 16 for descriptive statistics).

Indulgent food consumption. Participants reviewed their food diary and indicated whether they considered any of the foods they had eaten to be an "indulgent food," and if so, to indicate which one(s) were indulgent (see Appendix H). Then, the sum of the number of indulgent foods listed were calculated (see Table 16 for descriptive statistics).

Self-licensing. Participants reviewed their food diary and indicated whether they would not have eaten any of the foods listed if they had not exercised/watched cartoons the day before, and if so, to indicate which one(s) they would not have eaten (see Appendix H). Then, the sum of the number of indulgent foods listed were calculated (see Table 16 for descriptive statistics).

Data Analysis Plan

The data analysis was broken into three phases. First, to ensure that participants in the exercise conditions worked harder than participants in the control condition, physiological data were compared. In addition, to ensure that none of the psychological variables were too highly related, specifically the variables the measured constructs

related to both health and physical activity, the relations between the psychological variables were examined.

Second, a series of exploratory analyses on the individual paths of the full model were conducted. Because these analyses required multiple comparisons for each psychological variable, the Bonferroni correction was used to control for the family-wise error rate (originally developed by Holm, 1979). Using the Bonferroni correction for 8 comparisons, $\alpha = 0.00625$[2]. To provide a conceptual replication of the effects assessed in Study 1, the promotion and permitting conditions were collapsed into a single "exercise" condition, and their scores on the psychological measures were compared to those of the control condition using an independent-samples *t*-test. To compare the relative strength of each of the predictors, Cohen's *d* was calculated as a standardized effect size (Cohen, 1988). To assess whether there was an effect of the manipulations on cognitions, the effect of all three of the experimental conditions on the psychological variables was investigated using one-way ANOVAs. To compare the relative strength of the effects, the partial eta-squared (η_p^2) was calculated (Cohen, 1988; Miles & Shevlin, 2001). Similarly, differences in the eating behavior outcomes across the three experimental conditions were examined using one-way ANOVAs. Finally, the correlations between each of the psychological constructs and each of the eating behavior outcomes were examined.

Third, the full model was tested using the bootstrapping method with bias-corrected confidence estimates using Hayes' PROCESS macro for SPSS (see Figure 2).

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[2] Differences between groups were considered significant when the *p*-value was less than $\alpha = 0.00625$, and differences between groups were considered to trend towards significance when the *p*-value was less than 0.05.

Because the present experimental design involved three groups that served as predictors, indicator coding was used to code the multicategorical variable *X* in which D_1 represented participants in the promotion condition, D_2 represented participants in the permitting condition, and the control group served as the reference group (Hayes, 2018). In the PROCESS macro, regression analyses were run in which each psychological construct was the criterion variable and the indicator variables were the predictor variables to calculate the coefficients and standard errors for Paths a_1 and a_2. Similarly, regression analyses in the PROCESS macro were run in which the eating outcome was the criterion variable and the indicator variables and respective psychological construct were the predictor variables to calculate the coefficients for Path b. Although the PROCESS macro also provides the coefficients for Paths c and c', only if the coefficients for Path a_1 and Path b or the coefficients for Path a_2 and Path b were significant or trended towards significance were the indirect effects examined using the bootstrapping method with bias-corrected confidence estimates (MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2004) in which the 95% confidence interval of the indirect effect was calculated using 5,000 bootstrapped resamples (Preacher & Hayes, 2008).

Results

Preliminary Analyses

Physiological differences across experimental conditions. There was an effect of resting heart rate across conditions, and Tukey's HSD post-hoc comparisons showed that participants in the promotion condition had significantly higher resting heart rates than participants in the control condition (see Table 17 for statistics). There was evidence that participants in the two exercise conditions worked harder than participants in the

control condition: They had significantly higher average heart rates, maximum heart rates, and burned more calories than did participants in the control condition (see Table 17 for statistics).

Relations between the psychological variables. Table 18 shows the correlations between the psychological variables. Affective health attitudes and affective physical activity attitudes were correlated very highly (r = 0.78), so, as was decided *a priori*, only the measures for affective and instrumental health attitudes were used for the remainder of the analyses, and affective and instrumental physical activity attitudes were dropped.

Differences in the Psychological Variables Across Conditions

The effect of exercise on the psychological variables. Participants who exercised had significantly higher health self-efficacy and marginally higher health goal commitment and self-control resources than did participants in the control condition (see Table 19 for statistics). There was a similar, albeit non-significant, pattern of differences for physical activity self-efficacy, affective health attitudes, and perceived goal progress, but not for instrumental health attitudes or health identity.

The effect of condition on the psychological variables. There were significant differences between the three conditions (promotion v. permitting v. control) in health self-efficacy and self-control resources (see Table 20 for statistics). Post-hoc comparisons using Tukey's HSD revealed significant differences between the permitting and the control conditions in health self-efficacy (p = .001) and self-control resources (p = .004; see Table 20 for statistics). There were trends toward differences between the three groups in physical activity self-efficacy, affective health attitudes, and health goal

commitment, but no differences between groups in instrumental health attitudes, health identity, or perceived goal progress.

Testing Whether the Psychological Variables Mediate the Relations Between Conditions and Eating Outcomes

Hypotheses 3a: Exposure to the promotion manipulation will lead to increased consumption of fruits and vegetables and will be mediated by increases in health self-efficacy, health attitudes, health identity, and health goal commitment.

Effect of condition on consumption of servings of fruits and vegetables. There was not a significant effect of condition (promotion v. permitting v. control) on the number of servings of fruits and vegetables consumed during the day, $F(2, 188) = .37$, $p = .69$ (see Table 21 for statistics), contrary to the hypothesis.

Relations between psychological constructs and servings of fruits and vegetables. Analyses showed that health self-efficacy, physical activity self-efficacy, health identity, health goal commitment, health goal progress, and self-control resources were significantly, albeit weakly correlated with the number of servings of fruits and vegetables consumed (see Table 22 for correlations). There was no relation between servings of fruits and vegetables and instrumental health attitudes or affective health attitudes.

Mediation by psychological variables of servings of fruits and vegetables. First, for the promotion condition, Paths a_i and b were marginally significant for health goal commitment, so the indirect effects from the mediation analysis were examined (see Table 23 for statistics). The indirect effect for health goal commitment was significant ($a_ib = .15$, $SE = .08$, 95% CI = .03, .37); on average, participants assigned to the

promotion condition reported eating .15 more servings of fruits and vegetables, as mediated by health goal commitment.

Second, for the permitting condition, Path a_2 was significant for health self-efficacy and self-control resources and was marginally significant for physical activity self-efficacy and health goal commitment. Path b was significant for health self-efficacy and was marginally significant for physical activity self-efficacy, health goal commitment, and self-control resources. Therefore, the indirect effects from the mediation analysis were examined for each of these four variables (see Table 23 for statistics). The indirect effect for health self-efficacy was significant (a_2b = .40, *SE* = .14, 95% CI = .16, .73); on average, participants assigned to the permitting condition reported eating .40 more servings of fruits and vegetables, as mediated by health self-efficacy. Similarly, the indirect effect for physical activity self-efficacy was significant (a_2b = .20, *SE* = .14, 95% CI = .01, .62); on average, participants assigned to the permitting condition reported eating .20 more servings of fruits and vegetables, as mediated by physical activity self-efficacy. The indirect effect for health goal commitment was also significant (a_2b = .14, *SE* = .10, 95% CI = .004, .42); on average, participants assigned to the permitting condition reported eating .14 more servings of fruits and vegetables, as mediated by health goal commitment. Finally, the indirect effect for self-control resources was significant (a_2b = .07, *SE* = .09, 95% CI = .06, .50); on average, participants assigned to the permitting condition reported eating .07 more servings of fruits and vegetables, as mediated by self-control resources.

Hypotheses 3b: Exposure to the promotion manipulation will lead to the consumption of fewer calories from fat and will be mediated by increases in health self-efficacy, health attitudes, health identity, and health goal commitment.

Effect of condition on percentage of calories consumed from fat. Contrary to this hypothesis, there was not a significant effect of condition on the percentage of calories consumed from fat, $F(2, 188) = 1.08$, $p = .34$, (see Table 21 for statistics).

Relations between psychological constructs and percentage of calories consumed from fat. None of the psychological variables were significantly correlated with, nor were they predictors of the percentage of calories consumed from fat (see Tables 22 & 24 for correlations and statistics). Therefore, the indirect effects from the mediation analyses were not examined.

Hypotheses 3c: Exposure to the promotion manipulation will lead to the consumption of fewer calories from sugar and will be mediated by increases in health self-efficacy, health attitudes, health identity, and health goal commitment.

Effect of condition on percentage of calories consumed from sugar. There was not a significant effect of condition on the percentage of calories consumed from sugar, $F(2, 188) = .75$, $p = .47$. This is counter to the prediction from Hypothesis 3c (see Table 21 for statistics).

Relations between psychological constructs and percentage of calories consumed from sugar. Only one of the psychological variables – health identity – was significantly correlated with the percentage of calories from sugar, suggesting a weak negative relationship between the two (see Table 22 for correlations).

Mediation by psychological variables of percentage of calories consumed from sugar. The coefficients and the standard errors for paths a_1 and a_2 are the same as those considered in the mediational models for the consumption of fruits and vegetables (see Tables 23-27). Only health identity and self-control resources were marginally significant predictors of the percentage of calories from sugar (see Table 25 for statistics).

Path a_2 was significant and Path b was marginally significant for self-control resources, so the indirect effect from the mediation analysis was examined. These results indicated that the indirect effect was significant (a_2b = -.80, SE = .49, 95% CI = -2.13, -.12); on average, participants assigned to the permitting condition reported eating .80 fewer percentage of calories from sugar, as mediated by self-control resources.

Hypothesis 3d: Exposure to the permitting manipulation will lead to increased consumption of indulgent foods and will be mediated by increases in goal progress and decreases in self-control resources.

Effect of condition on number of indulgent foods consumed. There was not a significant effect of condition on the number of indulgent foods consumed, $F(2, 188)$ = .53, p = .59, which is counter to the prediction from Hypothesis 3d (see Table 21 for statistics).

Relations between psychological constructs and number of indulgent foods consumed. Only three of the psychological variables – affective health attitudes, health identity, and self-control resources – were significantly correlated with number of indulgent foods consumed, suggesting weak negative relationships between each pair (see Table 22 for correlations).

Mediation by psychological variables of number of indulgent foods consumed. The coefficients and the standard errors for Paths a_1 and a_2 are the same as indicated previously (see Tables 23-27 for statistics). Affective health attitudes and self-control resources were significant predictors of the number of indulgent foods consumed, and health identity was a marginal predictor of the number of indulgent foods consumed (see Table 26 for statistics).

For the permitting condition, Path a_2 was marginally significant for affective health attitudes and was significant for self-control resources. Path b was significant for both affective health attitudes and self-control resources, so the indirect effects from those mediation analyses were examined. The results indicated that the indirect effect for affective health attitudes was significant (a_2b = -.13, *SE* = .06, 95% CI = -.29, -.03), suggesting that participants in the permitting condition reported eating .13 fewer indulgent foods, as mediated by affective health attitudes. The results also indicated that the indirect effect for self-control resources was significant (a_2b = -.15, *SE* = .08, 95% CI = -.37, .-04). Therefore, participants assigned to the permitting condition reported eating .15 fewer indulgent foods, as mediated by self-control resources.

Hypothesis 3e: Exposure to the permitting manipulation will lead to increased consumption of self-licensed foods and will be mediated by increases in goal progress and decreases in self-control resources.

Effect of condition on number of self-licensed foods consumed. There was not a significant effect of condition on the number of self-licensed foods consumed, $F(2, 188) = .35$, $p = .71$, contrary to the hypothesis (see Table 21 for statistics).

Relations between psychological constructs and number of self-licensed foods consumed. None of the other psychological variables were significantly related to, nor were they predictors of, the number of self-licensed foods eaten during the day (see Tables 22 & 27 for correlations and statistics). Therefore, the indirect effects from the mediation analyses were not examined.

Discussion

The primary goal of Study 2 was to examine whether the way people think about an exercise session influences their subsequent eating behavior, and if so, whether this effect is mediated by the psychological variables that were found to be influenced by exercise in Study 1. The results from Study 2 did not provide substantial support for the hypothesized effects, although there was some evidence for aspects of the model. Exercising and watching the permitting video led to increased fruit and vegetable consumption, as mediated independently by health self-efficacy, physical activity self-efficacy, health goal commitment and self-control resources, to decreased percentage of calories from sugar consumed, as mediated by increases in self-control resources, as well as to decreased consumption of indulgent foods, as mediated by increases in affective health attitudes and self-control resources. Exercising and watching the promotion video led to increased fruit and vegetable consumption, as mediated by health goal commitment.

Explanations for the Lack of an Effect of Exercise on Eating Behavior

Methodological explanations. Study 2 provided a thorough, controlled test of whether the psychological variables could mediate the relation between an exercise

session and subsequent eating behavior. However, there are a number of methodological limitations that may explain the lack of an effect of exercise on later eating behavior.

Targeting multiple psychological variables in video manipulations. The video manipulations were designed to influence multiple psychological constructs at once versus manipulating each variable independently in a separate video. Due to constraints on time and the number of participants who could be recruited, creating one manipulation that was designed to change the constructs that were expected to lead to a promotion spillover (i.e., self-efficacy, attitudes, identity, and goal commitment) and one that was designed to change the constructs that were expected to lead to a permitting spillover (i.e., goal progress and self-control resources) seemed like a reasonable compromise when designing the study. However, because the videos targeted multiple psychological constructs, some may have been more strongly affected than others. Future research using this model should test each of the proposed pathways individually – that is, attempt to manipulate each of the psychological variables independently – and examine the conditions under which one pathway is stronger than the other pathways.

Exercise session. Although the physiological data indicated that participants in the exercise conditions had elevated heart rates and burned more calories compared in the control group, it is possible that the in-laboratory, moderate-intensity exercise session was not sufficiently demanding of participants to have a direct effect on eating behavior. Many participants in Study 2 had to be told repeatedly throughout the session to slow down or to reduce the resistance on the stationary bicycle in order to keep their heart rates within the moderate-intensity zone. This behavior implies that it is possible that it was perceived to be less intense than what participants would have done of their own volition.

It is possible that had participants been able to exercise for a longer duration or at a higher intensity, there would have been more intense changes in the psychological variables which would have ultimately led to differences in eating behavior.

Measurement of eating behavior. Study 1's assessment of eating behavior was limited to the use of a snack choice between an apple and a chocolate bar that took place in front of a research assistant, so in Study 2, eating behavior was measured through food log entries outside of the laboratory. Although this shift in assessment addressed some of the limitations from Study 1 by reducing the likelihood of demand characteristics, especially self-presentational concerns (e.g., Herman et al., 2003; Mori et al., 1987; Pliner & Chaiken, 1990; Roth et al., 2001), by measuring eating outside the presence of the experimenters rather than food choice in the presence of the experimenters, and by increasing the variability in eating behavior, it was not without its own limitations that made it difficult to be sufficiently precise when measuring eating behavior. One major concern with using the food diaries was that participants may have been imperfect at logging what they ate: they may have forgotten to log certain foods or may have made errors when estimating servings sizes that may have affected the eating outcomes. Furthermore, research suggests that people may underreport what they would have eaten when using food diaries because they consciously modify their diet when it is being recorded, become more aware of what they are eating and therefore change their eating behavior, or due to self-presentational concerns, fail to report the type or quantity of food that they actually consume (Macdiarmid & Blundell, 1997). Finally, even though LoseIt! received an "Excellent" rating for its nutritional database (Darby et al., 2016), there were

still some incomplete food entries that had to be supplemented using an additional food logging application – MyFitnessPal.

Furthermore, the eating behavior outcomes of percentage of calories consumed from fat and percentage of calories consumed from sugar may have been imperfect ways to measure unhealthy eating. Although some unhealthy foods like French fries and cakes/cookies are clearly high in fat, some healthy foods including avocados, nuts, and healthy oils like olive oil are also relatively high in fat. Similarly, although some unhealthy foods like candies or sugar-sweetened beverages are obviously high in sugar, certain healthy foods like fruits also contain sugar. Future research is needed to examine the difference between healthy fats/sugars and unhealthy fats/sugars to determine whether the psychological variables are predictive of differences between the two.

Another limitation in the measurement of eating behavior specifically concerns that of self-licensing. Although many participants ate indulgent foods, very few participants reported self-licensing, or eating something that they would not have eaten if they had not exercised/watched cartoons in the laboratory (n = 26). The question was written to be face-valid, but it is possible that participants may have interpreted it as asking whether they made a more planful and purposeful decision to eat something they would not have otherwise. Even if participants were aware that they had eaten something they may not have otherwise, they may have been reluctant to share that information with the research team due to self-presentational concerns (e.g., Herman et al., 2003; Mori et al., 1987; Pliner & Chaiken, 1990; Roth et al., 2001). It is also possible that people think of self-licensing in terms of calories than in terms of foods consumed (e.g., “I burnt 200 calories when exercising, so I earned an extra 200 calories to eat today”), which would

not have been captured by the self-licensing question that was used here. A final limitation is that self-licensing was measured the day after the food diary was completed, and so participants may not have remembered their thoughts about eating certain foods from the previous day.

Participant limitations. Due to time and resource constraints, this study recruited solely from a university research pool. Compared to other populations, university students may be more restricted in their eating options. For one, if they have a university dining plan, they are limited to the food options that are available in the cafeteria on a given day. Furthermore, most dining halls have fast food (i.e., hamburgers and French fries) and dessert options (i.e., cookies and ice cream) readily available. This may explain why the majority of participants reported eating at least one indulgent food throughout the remainder of the day. Fast foods and desserts are arguably more appetizing, and so participants might have chosen these foods over healthier options with more fruits and vegetables. Furthermore, even for students not on meal plans, due to limited incomes and time for cooking, they may have fewer options available at home than other populations. Therefore, even if the manipulations influenced the psychological variables in ways that should promote healthy eating, they may not have had healthy options like fruits and vegetables available or may not have had the time to prepare them.

Conceptual explanations. Conceptually, there are a few possibilities for why the hypothesized effects were not found. For one, the promotion spillover video was meant to convey the message that the strategies used to exercise regularly like discipline and planning could be applied to other health behaviors and was intended to change the psychological constructs that were hypothesized to lead to healthy eating – self-efficacy,

attitudes, health identity, and goal commitment. It may have been erroneous to assume that a discussion of long-term transfer strategies would affect state measures of the psychological variables. Instead, the message conveyed by the promotion video may have suggested to viewers that with time and practice, exercise would build the skills necessary to promote other health behaviors, which is theoretically different from exercise influencing psychological variables that would affect eating behavior in the short-term. Therefore, a single laboratory exercise session may not have been sufficient for participants to feel as though they had mastered the skills necessary for exercise to lead to other health behaviors, and so, promotion spillovers did not occur.

Second, the permitting spillover video was created to convey the message that exercise is a means to an end and that it offsets other unhealthy behaviors. It was thought that after hearing this message, participants would be more willing to self-license and engage in unhealthy eating behavior after exercising. Theoretically, it may have been misguided to assume that this message would lead to further self-licensing behavior. Instead, participants may have observed the unhealthy behaviors portrayed in the video as ones that they already did and so they did not want to further engage in any more deleterious behavior like unhealthy eating after watching it; therefore, permitting spillovers did not occur.

Explanations for Indirect Effects of Condition on Eating Behavior Through Psychological Pathways

Promotion video effects. Surprisingly, the message from the promotion video combined with the completed exercise session led to just one promotion spillover – increased fruit and vegetable consumption – as mediated by increases in health goal

commitment. As just discussed, it is possible that the message delivered did not lead to more of the anticipated effects because it targeted strategies that might take might time to develop instead of addressing the immediate psychological consequences of exercise that were predicted to lead to short-term changes in eating behavior. However, the recognition that the use of these strategies might be beneficial in the long-term may explain the short-term increase in health goal commitment after watching the promotion video.

Permitting video effects. Unexpectedly, the message conveyed by the permitting video in conjunction with the completed exercise session led to three promotion spillovers (i.e., increased fruit and vegetable consumption, decreased percentage of calories from sugar consumed, and decreased indulgent food consumption) through two of the psychological variables - self-efficacy and goal commitment – that were initially expected to lead to healthier eating behavior after exercise and one that was not – self-control resources. One explanation for this unanticipated effect is that when watching the video, participants recognized the unhealthy behaviors as things that they personally did and felt motivated to offset any negative effects from those behaviors. Because the video depicted exercise as one way to do this and they had just successfully completed an exercise session, they felt more capable of doing health behaviors, and exercise specifically, which was manifested by increased levels of health self-efficacy and physical activity self-efficacy. Similarly, the experience of completing the exercise session may have contributed to the feeling that health behaviors in general were more enjoyable, leading to the increase in affective health attitudes. The feeling that they were more capable of engaging in health behaviors and that health behaviors were more pleasant then led to increased fruit and vegetable consumption (e.g., Jackson et al., 2007;

Lawton et al., 2009). Furthermore, even if they recognized the unhealthy behaviors as something that they did occasionally, participants also would have just observed themselves engaging in an activity that required self-control, so through self-perception (Bem, 1972), they felt that they had elevated levels of self-control. In turn, this increased self-control predicted eating more fruits and vegetables, eating fewer calories from sugar, and eating fewer indulgent foods, which is consistent with the idea that having greater self-control is related to performing more health behaviors and the ability to regulate one's behavior and not give in to temptations (e.g., Hagger et al., 2009; Wills, Isasi, Mendoza, & Ainette, 2007).

Interpretation of the Present Findings

The results of Study 2 suggest that manipulating the way people think about an exercise session did not substantially influence subsequent real-world eating behavior, despite moderate changes in the psychological variables after exercise. The finding that exercise did not affect eating behavior is consistent with past research on the physiological relationship between exercise and eating behavior – there were no consistent effects of increased exercise on eating behavior or macronutrient composition (e.g., Donnelly et al., 2014), energy intake (e.g., Bilski et al., 2009; King et al., 2013; Melzer et al., 2005; Schubert et al., 2013), or hunger (King et al., 2013). As such, eating behavior within the 24-hour period following exercise may be fairly independent of both psychological and physiological influence.

Strengths and Contributions

Despite the lack of substantial findings, Study 2 was a well-designed, well-controlled test of one health behavior on a later health behavior.

Methodological control. One of the primary strengths of the present study was the amount of control exerted over the laboratory exercise session. Every participant exercised on the same stationary bicycle, in the same room, without listening to music or watching anything, and using a standardized heart-rate protocol for a moderate-intensity exercise session (Hogan et al., 2013). Therefore, one can be confident that the changes in the psychological variables compared to the control group are attributable to the exercise session.

Hybrid laboratory and field methodology. Most studies investigating the physiological relation between a controlled exercise session and subsequent eating behavior offered participants a test meal or monitored their eating behavior at a buffet in the laboratory (see Donnelly et al., 2014 for a review). Therefore, another unique contribution of the present research was the use of a hybrid methodology to investigate two health behaviors such that the first behavior – exercise – was done in a controlled laboratory setting, whereas the second behavior – eating behavior – was completed naturalistically. This was done to examine whether a standardized exercise session would affect real-world eating behavior and to increase the external generalizability of the present findings.

Conclusion

In summary, although Study 2 provided a strong empirical test of the model, the results do not support the hypothesized predictions that manipulating the way people perceived a moderate-intensity exercise session would substantially influence multiple components of their eating behavior throughout the remainder of the day through the psychological variables presented in the model.

General Discussion

The goal of this research program was to begin to understand the ways in which completing a single instance of one health-related behavior may influence the performance of a later health-related behavior. It is important to understand how different health behaviors might influence one another because the performance of multiple health-related behaviors is necessary for achieving and maintaining optimal health (Loef & Walach, 2012). To date, psychological theories have primarily focused on the psychological factors that precede a single type of health behavior (Noar et al., 2008). Although there has been a recent increase in interest in multiple-health-behavior-change interventions (Prochaska et al., 2008; King et al., 2015), they are limited in number and primarily focus on changing multiple behaviors concurrently. Some researchers have started to discuss and conduct research on how performing a single instance of a health-related behavior can influence the performance of a subsequent, different health-related behavior (e.g., how thinking about an exercise session as exercise or fun or as a "fat-burning" or "endurance" activity affects subsequent eating behavior; Fenzl et al., 2015; Werle et al., 2015).

Several research literatures suggest that there is ample reason to believe that the performance of one health behavior may affect the subsequent performance of a different health behavior. These literatures include the work on behavioral spillover (Thøgersen, 1999; Thøgersen & Ölander, 2003), Dolan and Galizzi's (2015) framework of behavioral spillover, and the lines of research on transfer cognitions (Barnett & Ceci, 2002) and on compensatory health beliefs (Knäuper et al., 2004; Rabiau et al., 2006). However, there is variation across the literature in whether this refers to the general performance of one

class of behaviors spilling over into another class of behaviors or whether this refers to the single instance of one behavior affecting the single occurrence of a second behavior. Although it has been posited that transfer cognitions can facilitate a promotion spillover between two sequential behaviors in the short-term (Fleig et al., 2011), most research on transfer has examined how thoughts about completing one health behavior mediate increases in another health behavior over time (e.g., Fleig et al., 2015) and has not explicitly tested the psychological mechanisms by which thinking about the performance of one health behavior would promote the performance of a subsequent different health behavior. Relatedly, although research on compensatory health beliefs has demonstrated that they can be activated immediately after performing an unhealthy behavior (e.g., Kronick & Knäuper, 2010), other studies have suggested that generally holding the beliefs that healthy behaviors can offset unhealthy ones is related to more unhealthy patterns of behavior (e.g., Berli et al., 2014; Knäuper et al., 2004).

To address this gap in the literature, this research presented a novel model in which six overarching psychological variables were proposed as mechanisms through which the performance of one health behavior might affect the later performance of a different health behavior: self-efficacy, attitudes, health identity, health goal commitment, health goal progress, and self-control resources.

Patterns of Changes in Psychological Variables After Exercising

The findings from two studies support the idea that the completion of a health behavior (i.e., an acute exercise session) led to consequential psychological changes, as suggested by the model. In Study 1, there were increases from pre- to post-exercise in all of the psychological variables assessed (i.e., health self-efficacy, physical activity self-

efficacy, instrumental health attitudes, affective health attitudes, health identity, health goal commitment, health goal progress, and self-control resources). In Study 2, participants who exercised reported higher levels of all but three – instrumental health attitudes, health identity, and health goal progress – of the psychological variables compared to people in a control group, who had not exercised.

These findings extend past research on behavior as a predictor of psychological variables in that most previous research has focused on how patterns of behavior or long-term interventions lead to psychological change, whereas the present research focused on the psychological effects of a single instance of one behavior. To illustrate, behavioral interventions have been shown to increase self-efficacy (e.g., Ashford et al., 2010; Hyde et al., 2008; Lewis et al., 2002). Similarly, through self-perception (Bem, 1972), past patterns of behavior have been shown to predict attitudes towards that behavior (e.g., Hagger et al., 2001; McEachan et al., 2011) and behavior-specific identities (e.g., Lee et al., 1999; Van der Werff et al., 2014; Vangeli & West, 2012). The present research suggests that the successful performance of just one health behavior can also lead to increases in both health- and behavior-specific self-efficacy and attitudes towards health behaviors, particularly affective attitudes. So, through self-perception (Bem, 1972), after completing one behavior, it appears that people infer that they are capable of performing not only that specific behavior, but also related behaviors and feel more positively about performing similar behaviors.

However, the lack of a difference in instrumental health attitudes between groups in Study 2 was inconsistent with what was observed in Study 1. In fact, this null effect may have been due to a ceiling effect: Participants held very high instrumental health

attitudes, such that the means for all three groups were above 6 on a 7-point scale. This suggests that people firmly hold the belief that engaging in health-promoting behaviors is useful, wise, and beneficial, and so there is little room for change, even after completing an attitude-consistent behavior such as an acute exercise session. Therefore, in order to have detected an effect, it may have been beneficial to use a scale with finer grained distinctions, particularly at the high end.

Although health identity did increase from pre- to post-exercise in Study 1, it appeared to be more stable and less amenable to change after a single behavior in Study 2. The hypothesis was that after exercising, the part of participants' identity related to health would be activated and more salient in their minds (Markus & Kunda, 1986; Markus & Wurf, 1987; Turner, 1985), but it may be that people's health identities are quite stable, particularly if they are regular exercisers. Regular exercisers were by definition people who engaged in multiple exercise sessions per week, so when asked to reflect on the extent to which they identified as a healthy individual, that consistent behavior may have informed their self-perception. Furthermore, because physical activity has been shown to co-occur with other health-promoting behaviors (e.g., Patterson et al., 1994; Spengler et al., 2012), it is possible that these individuals also regularly performed other health behaviors, which informed the strength of their health identity. Because regular exercisers were evenly distributed across the exercise and control conditions, there was no observable difference in health identity between conditions. It is also possible that the repeated-measures design used in Study 1 led to a demand effect such that participants thought they were supposed to feel more like a healthy individual after exercise compared to how they felt before it and responded accordingly. Another

possibility is that because the exercise session in Study 2 was part of a research study and took place in the psychology department instead of the recreational center as in Study 1, other facets of participants' identities such as "psychology student" or "research participant" were more salient, or at least more salient than their health identity.

However, not all previous research has focused on the psychological effects of patterns of behavior; research on goal commitment, goal progress, and self-control resources has established that successfully completing a single behavior can inform goal commitment (e.g., Bem, 1972; Soman & Cheema, 2004), that completing one behavior that indicates the achievement of a specific sub-goal within a broader-level goal is indicative of goal progress (Brunstein, 1993; Cantor & Kihlstrom, 1987), and that the completion of a behavior requiring self-control led to reduced self-control on subsequent tasks (e.g., Baumeister et al., 1998; Hagger et al., 2009; Muraven et al., 1998). The present research confirms the findings that completing a single behavior (i.e., an exercise session) can lead to higher levels of commitment to health goals, although perceptions that progress towards health goals had been made were inconsistent across the two studies. Like before, it is possible that participants did not perceive the laboratory exercise session as sufficiently intense or long in duration to count as progress towards their health or exercise goals.

Although it was hypothesized that completing a health behavior would be depleting and lead to decreases in self-control resources (e.g., Baumeister et al., 1998; Vohs & Heatherton, 2000), across both studies, participants actually reported *greater* levels of self-control after exercising. The idea was that exercising would be depleting in the same way that past research has shown decreased levels of self-control in a

subsequent self-control task after people override their impulses *not* to engage in an unhealthy behavior such as eating indulgent foods (Baumeister et al., 1998; Hagger et al., 2009) or drinking alcohol (Muraven & Schmueli, 2006). It is possible that the combination of completing a health-promoting behavior and using a self-report measure of self-control (versus measuring it through performance on a subsequent self-control task in a different domain) led participants to perceive the exercise session as a self-regulatory success that indicated that they had good self-control. Through self-perception (Bem, 1972), when later asked to consciously reflect on their level of self-control, they then reported higher levels of self-control after exercising than if they had not just engaged in the exercise session. Future research should substantiate this finding using different health promoting behaviors as the antecedent and by measuring self-control in different ways.

Changes in Eating Behavior After Exercising

Although completing an exercise session led to changes in the psychological variables, it was more difficult to detect an effect of exercise behavior on eating behavior in both studies. In Study 1, there were no differences in snack choice following the exercise session. It is possible that this was due to demand characteristics, specifically self-presentational concerns (e.g., Herman et al., 2003; Mori et al., 1987; Pliner & Chaiken, 1990; Roth et al., 2001), such that participants felt obligated to take the healthy snack offered by the research assistant in the recreational center lobby.

However, in Study 2, when eating behavior was measured holistically and recorded privately, there were similarly no differences in eating behavior across conditions. Participants' actual eating behavior throughout the remainder of the day was

used as the dependent measure, in order to increase variability in the responses and to increase the external generalizability of the findings. However, what participants ate may have been limited by the options available in the university cafeterias or in their off-campus apartments. To ensure that changes in eating behavior are caused by the experimental manipulations and are not due to limitations in what is available in participants' eating environments, future research could exert more control over eating behavior by standardizing the food options that are available. For example, one possibility would be to have participants hypothetically select a meal from a pre-determined menu after exercising or to have participants select and eat a meal from a buffet in the laboratory.

However, there was some evidence for aspects of the full model. Exercising and watching the permitting video led to increased fruit and vegetable consumption, as mediated by health self-efficacy, physical activity self-efficacy, health goal commitment and self-control resources, to decreased percentage of calories from sugar consumed, as mediated by self-control resources, and to decreased consumption of indulgent foods, as mediated by affective health attitudes and self-control resources. Exercising and watching the promotion video led to increased fruit and vegetable consumption, as mediated by health goal commitment. It is possible that there were more indirect effects on fruit and vegetable consumption and indulgent food consumption because these are eating outcomes in which people can make a choice to either consume or not consume a fruit/vegetable or an indulgent food. Therefore, these behaviors may have been more likely to be influenced by changes in the psychological variables than an eating outcome like percentage of calories consumed from fat/sugar, which may have been influenced by

either healthy or unhealthy choices. However, the singular indirect effect on decreased percentage of calories from sugar consumed may have been because higher levels of self-control were necessary to resist the temptation to eat unhealthy foods that were obviously high in sugar.

Theoretical Implications

Although the present findings are too preliminary to begin discussing the theoretical implications of the current model for health-behavior change theory more broadly, the psychological variables proposed in the present model may be applied specifically to research on behavioral spillover. More precisely, there was evidence that participants who felt more efficacious, were more committed to their health goals, had more positive affective health attitudes, and felt increased levels of self-control ate more healthily after exercising, although paradoxically, they were more likely to be influenced by the message in the permitting video. Regardless of how these cognitions were strengthened, these psychological constructs may help explain how a promotion spillover (i.e., when a health behavior promotes the performance of a different healthy behavior; Dolan & Galizzi, 2015) occurs through transfer as co-occurrence (i.e., when people use the thoughts and strategies learned in one domain to support a similar behavior in a different domain in the short-term; Barnett & Ceci, 2002). In fact, Barnett and Ceci (2002) initially proposed, but did not empirically test, the idea that after successfully completing one behavior, people may become more confident in themselves or feel more positive about that behavior and then transfer that confidence or attitude to a second behavior. The current research confirms their predictions that self-efficacy, goal commitment, and attitudes, specifically affective attitudes, may be fruitful avenues of

research when examining the mechanisms through which transfer between two sequential behaviors occurs. It also suggests that researchers studying transfer might also examine how perceived levels of self-control may transfer from one health behavior to another. Given the unexpected consequences of the permitting video, future research should be conducted on how best to manipulate these variables before the first health-promoting behavior in order to ensure that it does in fact change these variables that can be transferred to a second health-promoting behavior.

Relatedly, the "exercise as a gateway behavior" hypothesis proposes that over time, exercise may spillover and promote the performance of other healthy behaviors (Blakely et al., 2004; Nigg et al., 1999) because as people exercise more, they observe positive changes in their health and attempt to maximize those benefits by performing other health-promoting behaviors (Tucker & Reicks, 2002). The current findings suggest that future research on this hypothesis might specifically test health-goal commitment as a mechanism through which exercise might act as a gateway behavior. After just one exercise session, people felt more committed to their health-related goals and this commitment in turn led to the consumption of more fruits and vegetables, regardless of which message they received. In the promotion condition, recognizing that the strategies used to exercise might be beneficial in the long-term might have explained why participants felt more committed towards their health goals, and in the permitting condition, realizing that exercise could offset unhealthy behaviors that they do may have also led them to feel more committed to their health goals. Therefore, it is possible that over time, encouraging individuals to think about exercise that will be beneficial for maximizing health benefits in other domains, but also as something that will excuse

occasional unhealthy behaviors will lead to increases in health goal commitment that would help exercise serve as a gateway behavior to healthy eating.

Strengths and Contributions

Concurrent study of multiple health behaviors. One of the primary contributions of the present research was that it demonstrates the continued need to explore multiple health behaviors together. Although the present findings were that eating behavior after exercise may be fairly independent psychological influence, this may have been attributable to limitations in how eating behavior was measured and in the participant population. Given that the performance of multiple health behaviors such as exercise and healthy eating additively benefit health (Loef & Walach, 2012), the substantial psychological changes after exercising suggest that further research on how these psychological states influence eating behavior are warranted.

Concurrent study of multiple psychological variables. Recently, Sheeran and colleagues (2017) noted that health-behavior change theories have explicated a large number of target psychological constructs, but, to date, there have been few tests of multiple targets at a time. They argue that examining multiple psychological variables simultaneously will help researchers understand which constructs are redundant with one another and which constructs may amplify each other to maximize behavior change. Although the theory of planned behavior measures more than one psychological construct by including attitudes and perceived behavioral control (a form of self-efficacy; Ajzen, 1985, 1991) and has been expanded to include identity as a predictor of overall behavior (Rise et al., 2010), this is one of the first studies to also include goal commitment, goal progress, and perceptions of self-control as consequences and predictors of behavior. As

anticipated, the psychological variables were somewhat related, but only attitudes towards health behaviors and attitudes towards physical activity were so highly correlated that they appeared redundant and dropped from the analyses. Research should continue to study multiple psychological variables to understand the specific combinations of constructs that lead to optimal behavior change and spillover.

Limitations and Future Directions

Despite the strengths of the present research, there are a few limitations to consider. For one, although the model could have been tested using any combination of health-promoting and unhealthy behaviors, it was examined using the two health-promoting behaviors of exercise and eating. Therefore, it is unclear how the model applies not only to other combinations of health-promoting behaviors (e.g., vaccination, safe sexual practices, flossing, etc.), but also to combinations of unhealthy behaviors (e.g., smoking, alcohol misuse, and sedentary behavior). Exercise and eating behavior were selected as the target behaviors in this initial examination of the model because not only are they uniquely related to one another in that in order to maintain one's weight, energy intake (i.e., eating behavior) must equal energy expenditure (i.e., exercise behavior), but also, some past research has found differences between people's *perceptions* at the completion of an exercise session and their subsequent eating behavior (e.g., Werle et al., 2015). Although there was some evidence that exercising influenced certain eating behaviors through some of the psychological pathways presented, the relation between exercise and eating behavior generally was weak or non-existent. Given that exercise and eating should intuitively be more strongly related to one another than other health behaviors (e.g., vaccination behavior and alcohol use), future research

refining the model and better understanding the psychological relation between exercise and eating behavior will be necessary before the model is applied to other combinations of health behaviors.

Another limitation is that in both studies, the psychological variables were measured just once immediately after the completion of the health behavior. Therefore, it is unclear how durable are the increases in the psychological variables. Future research should examine how long the changes in the psychological variables last. It is likely that the changes are strongest immediately after exercise and then return to the individual's baseline throughout the remainder of the day or until the individual completes another salient health behavior. This understanding would give insight into the temporal window in which spillover might occur following the performance of the first behavior.

Finally, participation in the present studies was limited to college students who were willing to complete an exercise session as part of a research study. It is possible that these individuals are already more health-conscious than their peers, and so they may have already held fairly strong and stable beliefs regarding health behaviors. Given that many of the psychological changes are thought to have occurred through self-perception processes (Bem, 1972) and that people with less well-established attitudes have been shown to be more susceptible to attitude change through self-perception compared to individuals with more stable attitudes (Chaiken & Baldwin, 1981), it is possible that less active individuals would show more extreme changes in the psychological variables following a single exercise session. Therefore, future research should test the model using different populations and should include people at different stages of health-behavior

change to understand whether the magnitude of psychological change is in fact greater for individuals with poorly defined beliefs about health behaviors.

Conclusion

Evidence from two studies suggests that the completion of a single health behavior (i.e., an acute exercise session) in both a naturalistic and a laboratory setting led to substantial psychological changes in health and physical activity self-efficacy, affective health attitudes, health goal commitment, health goal progress, and self-control resources, and to a lesser degree changes in instrumental health attitudes and health identity. Although exercising in general did not directly affect snack choice or eating behavior, it did indirectly affect three eating behaviors – fruit and vegetable consumption, percentage of calories consumed from sugar, and indulgent food consumption – through increased levels of self-efficacy, health goal commitment, self-control resources, and affective health attitudes. The model proposed and tested in this research consolidates six different areas of research into explanations for the mechanisms through which behavioral spillover between two health-promoting behaviors might occur. Future research refining this model will contribute to understanding the psychological relation between different health behaviors. Ultimately, this insight may be used to maximize the number of health behaviors that people perform, leading to a healthier population.

Table 1

Correlations Between Psychological Variables Pre-Exercise – Study 1

	1	2	3	4	5	6	7	8	9	10
1. Health Self-Efficacy	--									
2. PA Self-Efficacy	.45**	--								
3. Instrumental Health Attitudes	.37**	.18*	--							
4. Affective Health Attitudes	.38**	.25**	.43**	--						
5. Instrumental PA Attitudes	.34**	.24**	.65**	.34**	--					
6. Affective PA Attitudes	.37**	.36**	.27**	.54**	.45**	--				
7. Health Identity	.51**	.47**	.28**	.47**	.36**	.49**	--			
8. Health Goal Commitment	.35**	.45**	.07	.31**	.18*	.43**	.63**	--		
9. Health Goal Progress	.38**	.36**	.16*	.27**	.22**	.31**	.57**	.60**	--	

10. Self-Control Resources	.50**	.46**	.14*	.36**	.19**	.39**	.54**	.48**	.50**	--

Note: PA = Physical Activity; *$p < .05$; **$p < .01$

Table 2

Correlations Between Psychological Variables Post-Exercise – Study 1

	1	2	3	4	5	6	7	8	9	10
1. Health Self-Efficacy	--									
2. PA Self-Efficacy	.46**	--								
3. Instrumental Health Attitudes	.37**	.24**	--							
4. Affective Health Attitudes	.48**	.31**	.44**	--						
5. Instrumental PA Attitudes	.33**	.24**	.83**	.41**	--					
6. Affective PA Attitudes	.51**	.37**	.45**	.76**	.50**	--				
7. Health Identity	.46**	.43**	.45**	.48**	.47**	.48**	--			
8. Health Goal Commitment	.42**	.36**	.37**	.46**	.38**	.53**	.60**	--		

9. Health Goal Progress	.39**	.35**	.31**	.33**	.31**	.35**	.53**	.50**	--	
10. Self-Control Resources	.50**	.46**	.28**	.44**	.29**	.48**	.42**	.50**	.46**	--

Note: PA = Physical Activity; *$p < .05$; **$p < .01$

Table 3

Differences in Psychological Variables from Pre- to Post-Exercise

Psychological Variables	Pre-Exercise Mean (*SD*)	Post-Exercise Mean (*SD*)	*t*	*d*	95% CI of the Difference	
					Lower	Upper
Health Self-Efficacy	111.61 (13.92)	115.92 (13.65)	8.38***	.59	3.29	5.32
PA Self Efficacy	3.07 (.77)	3.19 (.79)	4.28***	.30	.07	.18
Instrumental Health Attitudes	6.41 (.62)	6.55 (.60)	2.37**	.29	.01	.15
Affective Health Attitudes	5.37 (.95)	5.61 (.85)	4.43***	.32	.13	.34
Health Identity	5.65 (.97)	5.85 (.92)	5.74***	.41	.13	.27
Health Goal Commitment	5.36 (1.09)	5.70 (.89)	5.94***	.42	.22	.45
Health Goal Progress	4.77 (1.08)	4.97 (1.07)	4.883***	.35	.12	.28
Self-Control Resources	4.77 (.89)	5.21 (.83)	9.71***	.59	.05	.35

Note: PA = Physical Activity; *$p < .05$, ** $p < .01$, ***$p < .001$; $df = 199$

Table 4

Differences in Exercise- versus Non-Exercise-Related Goals from Pre- to Post-Exercise

	Pre-Exercise Mean (*SD*)	Post-Exercise Mean (*SD*)	*t*	*df*	*d*	95% CI of the Difference	
						Lower	Upper
Exercise-Related Goals	4.83 (1.39)	5.07 (1.33)	3.41***	163	0.27	.10	.39
Non-Exercise-Related Goals	4.76 (1.26)	4.97 (1.22)	4.07***	195	0.29	.10	.29

Note: *$p < .05$, ** $p < .01$, ***$p < .001$

Table 5

Differences in Broad and Specific Exercise-Frequency Goals from Pre- to Post-Exercise

	Pre-Exercise Mean (*SD*)	Post-Exercise Mean (*SD*)	*t*	*df*	*d*	95% CI of the Difference	
						Lower	Upper
Broad Exercise-Frequency Goals	4.56 (1.44)	5.04 (1.25)	2.91**	33	0.50	.15	.82
Specific Exercise-Frequency Goals	4.60 (1.49)	4.92 (.40)	2.73**	54	0.37	.08	.55

Note: *$p < .05$, ** $p < .01$, ***$p < .001$

Table 6

Separate Logistic Regressions for Psychological Variables as Individual Predictors of Snack Choice

Psychological Variables	*B*	*SE*	Wald	*p*-value	Odds-Ratio
Health Self-Efficacy	.01	.03	.05	.82	1.01
Physical Activity Self-Efficacy	-.61	.43	2.02	.16	.54
Instrumental Health Attitudes	.35	.39	.79	.37	1.41
Affective Health Attitudes	-.30	.19	2.36	.12	.74
Health Identity	.15	.38	.16	.69	1.16
Health Goal Commitment	.28	.23	1.50	.22	1.32
Health Goal Progress	.09	.32	.08	.78	1.09
Self-Control Resources	.29	.29	.99	.32	1.34

Note: df = 1.

Table 7

Proportions of Participants Who Chose Each Snack by Time of Day

Snack Choice	Morning	Early Afternoon	Late Afternoon	Total
Apple	24 (85.7%)	56 (80.0%)	43 (71.7%)	123
Chocolate	4 (14.3%)	14 (20.0%)	17 (28.3%)	35
Total	28 (17.7%)	70 (44.3%)	60 (38.0%)	158

Table 8

Means of Psychological Variables Pre- and Post-Exercise by Regular Exerciser Status

	Regular Exerciser		Non-Regular Exerciser	
Psychological Variables	Pre-Exercise Mean (*SD*)	Post-Exercise Mean (*SD*)	Pre-Exercise Mean (*SD*)	Post-Exercise Mean (*SD*)
Health Self-Efficacy	112.59 (13.29)	116.38 (13.46)	107.92 (15.59)	114.38 (13.46)
PA Self-Efficacy	3.17 (.75)	3.29 (.78)	2.70 (.74)	2.85 (.75)
Instrumental Health Attitudes	6.46 (.60)	6.59 (.57)	6.24 (.66)	6.39 (.66)
Affective Health Attitudes	5.46 (.92)	5.65 (.83)	5.02 (1.00)	5.43 (.88)
Health Identity	5.83 (.89)	6.03 (.83)	4.98 (.97)	5.16 (.92)
Health Goal Commitment	5.57 (.93)	5.88 (.78)	4.61 (1.32)	5.05 (.99)
Health Goal Progress	4.95 (.99)	5.14 (1.00)	4.19 (1.19)	4.38 (1.13)
Self-Control Resources	4.83 (.87)	5.29 (.80)	4.57 (.94)	4.93 (.87)

Note: PA = Physical Activity

Table 9

Moderation of Changes in Psychological Variables from Pre- to Post-Exercise by Exerciser Status

Psychological Variables	Source	*F*	*p*-value	η^2
Health Self-Efficacy	Time	65.35	< .001	.25
	Regular Exerciser	2.33	.13	.01
	Time*Regular Exerciser	3.82	.05	.02
PA Self-Efficacy	Time	13.89	< .001	.07
	Regular Exerciser	12.93	< .001	.06
	Time*Regular Exerciser	.14	.70	.00
Instrumental Health Attitudes	Time	11.86	< .001	.06
	Regular Exerciser	4.82	.03	.02
	Time*Regular Exerciser	.25	.87	.00
Affective Health Attitudes	Time	21.25	< .001	.10
	Regular Exerciser	5.64	.02	.03
	Time*Regular Exerciser	3.02	.08	.02
Health Identity	Time	20.36	< .001	.09
	Regular Exerciser	35.63	< .001	.15
	Time*Regular Exerciser	.13	.72	.00
Health Goal Commitment	Time	29.06	< .001	.13
	Regular Exerciser	39.00	< .001	.17
	Time*Regular Exerciser	.89	.35	.00
Health Goal Progress	Time	15.56	< .001	.07
	Regular Exerciser	20.04	< .001	.09
	Time*Regular Exerciser	.00	.95	.00
Self-Control Resources	Time	56.19	< .001	.22
	Regular Exerciser	5.41	.02	.03
	Time*Regular Exerciser	.81	.37	.00

Note: PA = Physical Activity; *df* = 1, 197 for all *F*-tests, except *df*(within) is 190 for affective health attitudes due to missing data.

Table 10

Means of Psychological Variables Pre- and Post-Exercise by Type of Exercise

	Cardiovascular Training		Strength Training		Both Cardiovascular and Strength Training	
Psychological Variables	Pre-Exercise Mean (*SD*)	Post-Exercise Mean (*SD*)	Pre-Exercise Mean (*SD*)	Post-Exercise Mean (*SD*)	Pre-Exercise Mean (*SD*)	Post-Exercise Mean (*SD*)
Health Self-Efficacy	111.04 (14.61)	116.11 (13.88)	110.73 (12.07)	114.78 (10.53)	112.48 (13.52)	115.92 (14.07)
PA Self-Efficacy	3.02 (.84)	3.18 (.85)	3.32 (.64)	3.40 (.57)	3.07 (.72)	3.15 (.77)
Instrumental Health Attitudes	6.36 (.65)	6.51 (.64)	6.25 (.71)	6.43 (.52)	6.51 (.55)	6.62 (.55)
Affective Health Attitudes	5.30 (.99)	5.61 (.82)	5.30 (.92)	5.46 (.67)	5.47 (.91)	5.64 (.92)
Health Identity	5.43 (1.04)	5.65 (.97)	5.94 (.59)	6.14 (.54)	5.84 (.89)	6.02 (.87)
Health Goal Commitment	5.24 (1.18)	5.58 (.98)	5.65 (.70)	5.88 (.49)	5.45 (1.04)	5.80 (.84)
Health Goal Progress	4.57 (1.16)	4.86 (1.14)	5.06 (1.03)	5.26 (.96)	4.96 (.95)	5.04 (1.00)
Self-Control Resources	4.67 (.91)	5.22 (.87)	4.92 (.61)	5.10 (.68)	4.87 (.91)	5.23 (.81)

Note: PA = Physical Activity

Table 11

Moderation of Changes in Psychological Variables from Pre- to Post-Exercise by Type of Exercise

Psychological Variables	Source	*F*	*p*-value	η^2
Health Self-Efficacy	Time	37.02	< .001	.16
	Type of Exercise	.10	.90	.00
	Time*Type of Exercise	1.17	.31	.01
PA Self-Efficacy	Time	8.13	.005	.04
	Type of Exercise	.88	.42	.01
	Time*Type of Exercise	.95	.39	.01
Instrumental Health Attitudes	Time	10.58	.001	.05
	Type of Exercise	1.72	.18	.02
	Time*Type of Exercise	.18	.84	.00
Affective Health Attitudes	Time	8.62	.004	.04
	Type of Exercise	.49	.61	.01
	Time*Type of Exercise	.82	.44	.01
Health Identity	Time	17.88	< .001	.08
	Type of Exercise	5.31	.006	.05
	Time*Type of Exercise	.06	.94	.00
Health Goal Commitment	Time	16.48	< .001	.08
	Type of Exercise	1.84	.16	.02
	Time*Type of Exercise	.15	.86	.00
Health Goal Progress	Time	12.83	< .001	.06
	Type of Exercise	2.48	.086	.03
	Time*Type of Exercise	3.10	.047	.03
Self-Control Resources	Time	36.55	< .001	.16
	Type of Exercise	.37	.69	.00
	Time*Type of Exercise	3.72	.026	.04

Note: PA = Physical Activity; *df* = 1, 197 for time *F*-tests, except *df*(within) is 190 for affective health attitudes due to missing data; *df* = 2, 197 for type of exercise and time*type of exercise *F*-tests, , except *df*(within) is 190 for affective health attitudes due to missing data.

Table 12

Descriptive Statistics of Duration and Intensity of Study 1 Exercise Sessions

	Mean	SD	Min.	Max.
Duration	41.14	16.29	23.50	105.00
Intensity	6.95	1.14	3.00	10.00

Table 13

Duration of Exercise as a Predictor of Changes in Psychological Variables from Pre- to Post-Exercise

Psychological Variables		Unstandardized Coefficients				
		B	*SE*	*t*	*p*-value	R^2
Health Self-Efficacy	Intercept	5.36	1.40	3.83	< .001	.003
	Duration of Exercise	-.026	.03	-.81	.418	
PA Self-Efficacy	Intercept	.24	.08	3.11	.002	.014
	Duration of Exercise	-.003	.00	-1.65	.101	
Instrumental Health Attitudes	Intercept	.01	.09	.14	.890	.011
	Duration of Exercise	.003	.00	1.46	.147	
Affective Health Attitudes	Intercept	.48	.17	2.78	.006	.001
	Duration of Exercise	-.002	.00	-.49	.626	
Health Identity	Intercept	.23	.09	2.42	.016	.001
	Duration of Exercise	-.001	.00	-.34	.733	
Health Goal Commitment	Intercept	.34	.15	2.21	.03	.000
	Duration of Exercise	.000	.00	-.03	.97	
Health Goal Progress	Intercept	.36	.11	3.31	.001	.013
	Duration of Exercise	-.004	.00	-1.62	.107	
Self-Control Resources	Intercept	.78	.12	6.48	.000	.045
	Duration of Exercise	-.008	.00	-3.05	.003	

Note: PA = Physical Activity; *df* = 1, 198 for all *F*-tests, except *df*(within) is 190 for affective health attitudes due to missing data.

Table 14

Intensity of Exercise as a Predictor of Changes in Psychological Variables from Pre- to Post-Exercise

Psychological Construct Variable		Unstandardized Coefficients				
		B	Standard Error	*t*	*p*-value	R^2
Health Self-Efficacy	Intercept	6.43	3.19	2.02	.045	.002
	Intensity of Exercise	-.31	.45	-.68	.501	
PA Self-Efficacy	Intercept	.11	.18	.61	.544	.000
	Intensity of Exercise	.002	.03	.08	.934	
Instrumental Health Attitudes	Intercept	.06	.20	.28	.776	.001
	Intensity of Exercise	.01	.03	.37	.709	
Affective Health Attitudes	Intercept	.51	.40	1.27	.206	.000
	Intensity of Exercise	-.02	.06	-.26	.796	
Health Identity	Intercept	.08	.21	.36	.720	.002
	Intensity of Exercise	.02	.03	.57	.567	
Health Goal Commitment	Intercept	.45	.35	1.29	.199	.001
	Intensity of Exercise	-.02	.05	-.34	.737	
Health Goal Progress	Intercept	-.16	.25	-.63	.53	.010
	Intensity of Exercise	.05	.04	1.44	.15	
Self-Control Resources	Intercept	.08	.28	.29	.776	.008
	Intensity of Exercise	.02	.04	1.30	.194	

Note: PA = Physical Activity

Table 15

Reliability of Study 2 Psychological Variable Measures

	Health Self-Efficacy	Physical Activity Self-Efficacy	Instrumental Health Attitudes	Affective Health Attitudes	Instrumental Physical Activity Attitudes	Affective Physical Activity Attitudes	Health Identity	Health Goal Commitment	Health Goal Progress	Self-Control Resources
Cronbach's Alpha (α)	0.93	0.83	0.82	0.85	0.89	0.93	0.90	n/a	0.76	0.84

Table 16

Descriptive Statistics for Eating Outcomes

	N	Mean	*SD*	Min.	Max.
Servings of Fruits and Vegetables	191	1.98	2.37	.00	15.25
Percentage of Calories Consumed from Fat	191	33.98	9.61	12.25	71.45
Percentage of Calories Consumed from Sugar	191	15.26	9.28	.33	53.52
Number of Indulgent Foods Consumed	191	1.35	1.72	.00	7.00
Number of Self-Licensing Foods Consumed	191	.17	.53	.00	5.00

Table 17

Differences in Physiological Data between Promotion, Permitting, and Control Conditions

Physiological Data	Promotion Mean (*SD*)	Permitting Mean (*SD*)	Control Mean (*SD*)	*F* (2, 186)	η_p^2
Resting Heart Rate	77.84 (11.26)	76.10 (11.44)	72.96 (10.83	3.48*	.04
Average Heart Rate	131.17 (14.59)	126.4 (15.04)	77.03 (15.05	279.86**	.75
Maximum Heart Rate	160.24 (23.21)	160.77 (27.75)	110.82 (31.47)	71.99**	.44
Calories Burned	287.38 (96.37)	267.21 (77.80)	76.08 (41.01)	177.67**	.66

Table 18

Correlations Between Psychological Variables – Study 2

	1	2	3	4	5	6	7	8	9	10
1. Health Self-Efficacy	--									
2. PA Self-Efficacy	.50**	--								
3. Instrumental Health Attitudes	.30**	.13	--							
4. Affective Health Attitudes	.37**	.32**	.37**	--						
5. Instrumental PA Attitudes	.44**	.20**	.62**	.34**	--					
6. Affective PA Attitudes	.47**	.46**	.25**	.78**	.42**	--				
7. Health Identity	.50**	.49**	.16*	.54**	.32**	.61**	--			
8. Health Goal Commitment	.42**	.49**	.23**	.53**	.34**	.55**	.72**	--		
9. Health Goal Progress	.38**	.37**	.22**	.39**	.17*	.39**	.59**	.53**	--	

10. State Self-Control	.48**	.33**	.15*	.33**	.21**	.42**	.42**	.42**	.42**	--

Note: PA = Physical Activity; *$p < .05$; **$p < .01$

Table 19

Differences in Psychological Variables between Exercise and Control Conditions

Psychological Variables	Exercise Condition Mean (*SD*)	Control Condition Mean (*SD*)	*t* (*df* = 189)	*d*
Health Self-Efficacy	114.20 (15.20)	107.59 (15.93)	2.91**	.42
PA Self Efficacy	3.10 (.86)	2.83 (.83)	2.20*	.32
Instrumental Health Attitudes	6.40 (.69)	6.24 (.71)	1.59	.23
Affective Health Attitudes	5.39 (.96)	5.06 (1.10)	2.19*	.32
Health Identity	5.62 (1.18)	5.32 (1.44)	1.57	.23
Health Goal Commitment	5.45 (1.09)	4.98 (1.33)	2.68**	.39
Health Goal Progress	4.86 (1.06)	4.57 (1.15)	1.78	.26
Self-Control Resources	5.05 (.83)	4.73 (.80)	2.69**	.39

Note: PA = Physical Activity; *$p < .05$, **$p < .01$, ***$p < .001$; Due to missing data, the degrees of freedom for affective health attitudes was 186 and for goal progress was 188.

Table 20

Differences in Psychological Variables between Promotion, Permitting, and Control Conditions

Psychological Variables	Promotion Mean (*SD*)	Permitting Mean (*SD*)	Control Mean (*SD*)	*F* (2, 188)	η_p^2
Health Self-Efficacy	111.46 (13.98)	117.73 (16.11)	107.59 (15.93)	6.56**	.065
PA Self Efficacy	3.00 (.87)	3.24 (.84)	2.83 (.83)	3.58*	.037
Instrumental Health Attitudes	6.42 (.54)	6.38 (.84)	6.24 (.71)	1.31	.014
Affective Health Attitudes	5.23 (.93)	5.54 (.94)	5.06 (1.10)	3.33*	.035
Health Identity	5.55 (.94)	5.70 (1.44)	5.32 (1.44)	1.42	.015
Health Goal Commitment	5.45 (.82)	5.44 (1.37)	4.98 (1.33)	3.58*	.037
Health Goal Progress	4.92 (.95)	4.77 (1.19)	4.57 (1.15)	1.85	.019
Self-Control Resources	4.93 (.72)	5.21 (.95)	4.73 (.80)	25.27**	.053

Note: PA = Physical Activity; *$p < .05$, **$p < .01$, ***$p < .001$; *df*(within) is 185 for affective health attitudes and is 187 for health goal progress due to missing data.

Table 21

Differences in Eating Outcomes between Promotion, Permitting, and Control Conditions

Eating Outcomes	Promotion Mean (*SD*)	Permitting Mean (*SD*)	Control Mean (*SD*)	*F* (2, 188)	η_p^2
Servings of Fruits and Vegetables	2.18 (2.71)	1.93 (2.57)	1.84 (1.96)	.37	.004
Percentage of Calories Consumed from Fat	32.52 (8.92)	34.47 (9.94)	34.81 (9.92)	1.08	.01
Percentage of Calories Consumed from Sugar	14.20 (8.71)	16.36 (9.84)	15.52 (9.40)	.75	.008
Number of Indulgent Foods	1.47 (1.30)	1.25 (1.08)	1.31 (1.13)	.53	.006
Number of Self-Licensed Foods	.19 (.44)	.21 (.50)	.14 (.61)	.35	.004

Note: $*p < .05$, $**p < .01$, $***p < .001$; *df*(within) is 185 for number of indulgent foods due to missing data.

Table 22

Correlations between Psychological Variables and Eating Outcomes

	FV Servings	% Cals Fat	% Cals Sugar	# Indulgent Foods	# Self-Licensing Foods
Health Self-Efficacy	.25**	.01	.08	.02	.05
PA Self-Efficacy	.17*	-.05	-.01	-.05	-.08
Instrumental Health Attitudes	.09	-.06	.01	.01	.03
Affective Health Attitudes	.08	-.07	-.11	-.23**	-.07
Health Identity	.21**	-.01	-.17*	-.16*	-.09
Health Goal Commitment	.16*	-.01	-.11	-.13	-.12
Health Goal Progress	.17*	-.05	-.08	-.12	-.01
State Self-Control	.15*	.04	-.13	-.22**	-.04

Note: PA = Physical Activity; FV = Fruits and Vegetables; *$p < .05$; **$p < .01$; N = 191 for correlations with health self-efficacy, physical activity self-efficacy, instrumental health attitudes, health identity, health goal commitment, and self-control resources; N = 190 for correlations with health goal progress; N = 188 for correlations with affective health attitudes.

Table 23

Regression Coefficients, Standard Errors, and Model Summary Information for Mediation of Condition on Fruit and Vegetable Consumption by Psychological Variables

			Consequent									
			Y (FV_SERVING)				*M*				*Y* (FV_SERVING)	
Psychological Variable	Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Health Self-Efficacy (HSE)	D_1	c_1	.34	.40	.40	a_1	3.87	2.59	.14	c'_1	.19	.39	.63
	D_2	c_2	.09	.43	.84	a_2	10.14	2.80	< .001	c'_2	-.31	.44	.48
	M (HSE)		____	____	____		____	____	____	*b*	.04	.01	< .001
	Constant	i_Y	1.84	.26	< .001	i_M	107.60	1.71	< .001	i_Y	-2.39	1.21	.05
			R^2 = .004				R^2 = .065				R^2 = .068		
			$F(2, 188) = .37, p = .69$				$F(2, 188) = 6.56, p = .002$				$F(3, 187) = 4.57, p = .004$		
Physical Activity Self-Efficacy (PASE)	D_1	c_1	.34	.40	.40	a_1	.17	.14	.24	c'_1	.26	.40	.52
	D_2	c_2	.09	.43	.84	a_2	.41	.15	.008	c'_2	-.11	.44	.80
	M (PASE)		____	____	____		____	____	____	*b*	.49	.20	.02
	Constant	i_Y	1.84	.26	< .001	i_M	2.83	.09	< .001	i_Y	.47	.63	.46
			R^2 = .004				R^2 = .037				R^2 = .034		
			$F(2, 188) = .37, p = .69$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = 2.17, p = .09$		
Instrumental Health Attitudes (HAtt_Instr)	D_1	c_1	.34	.40	.40	a_1	.18	.12	.13	c'_1	.29	.40	.47
	D_2	c_2	.09	.43	.84	a_2	.14	.13	.28	c'_2	.05	.43	.90
	M (HAtt_Instr)		____	____	____		____	____	____	*b*	.27	.25	.28
	Constant	i_Y	1.84	.26	< .001	i_M	6.24	.08	< .001	i_Y	.16	1.58	.92
			R^2 = .004				R^2 = .02				R^2 = .01		

			$F(2, 188) = .37, p = .69$				$F(2, 188) = 1.31, p = .27$				$F(3, 187) = .64, p = .59$		
Affective Health Attitudes (HAtt_Aff)	D_1	c_1	.34	.41	.41	a_1	.21	.17	.22	c'_1	.30	.41	.47
	D_2	c_2	.09	.44	.84	a_2	.48	.19	.01	c'_2	.00	.45	.99
	M (HAtt_Aff)		____	____	____		____	____	____	b	.18	.17	.30
	Constant	i_Y	1.85	.27	< .001	i_M	5.06	.11	< .001	i_Y	.94	.91	.31
				$R^2 = .004$				$R^2 = .034$				$R^2 = .01$	
			$F(2, 185) = .35, p = .71$				$F(2, 185) = 3.33, p = .04$				$F(3, 184) = .59, p = .62$		
Health Identity (HID)	D_1	c_1	.34	.40	.40	a_1	.23	.22	.29	c'_1	.25	.39	.53
	D_2	c_2	.09	.43	.84	a_2	.38	.24	.11	c'_2	-.06	.43	.89
	M (HID)		____	____	____		____	____	____	b	.39	.13	.003
	Constant	i_Y	1.84	.26	< .001	i_M	5.32	.14	< .001	i_Y	-.23	.74	.76
				$R^2 = .004$				$R^2 = .015$				$R^2 = .049$	
			$F(2, 188) = .37, p = .69$				$F(2, 188) = 1.41, p = .25$				$F(3, 187) = 3.20, p = .02$		
Health Goal Commitment (Commit)	D_1	c_1	.34	.40	.40	a_1	.48	.20	.02	c'_1	.19	.40	.64
	D_2	c_2	.09	.43	.84	a_2	.46	.22	.04	c'_2	-.06	.43	.90
	M (Commit)		____	____	____		____	____	____	b	.31	.14	.03
	Constant	i_Y	1.84	.26	< .001	i_M	4.98	.13	< .001	i_Y	.29	.76	.70
				$R^2 = .004$				$R^2 = .037$				$R^2 = .029$	
			$F(2, 188) = .37, p = .69$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = 1.83, p = .14$		
Health Goal Progress (Prog)	D_1	c_1	.37	.40	.37	a_1	.35	.19	.06	c'_1	.24	.40	.56
	D_2	c_2	.09	.43	.84	a_2	.20	.20	.32	c'_2	.02	.43	.97
	M (Prog)		____	____	____		____	____	____	b	.36	.16	.02
	Constant	i_Y	1.84	.26	< .001	i_M	4.57	.12	< .001	i_Y	.20	.76	.79
				$R^2 = .005$				$R^2 = .019$				$R^2 = .032$	
			$F(2, 187) = .42, p = .66$				$F(2, 187) = 1.84, p = .16$				$F(3, 186) = 2.04, p = .11$		
	D_1	c_1	.34	.40	.40	a_1	.20	.14	.15	c'_1	.25	.40	.53

Self-Control Resources (SCR)	D_2	c_2	.09	.43	.84	a_2	.48	.15	.001	c'_2	-.12	.44	.79
	M (SSC)									*b*	.43	.21	.04
	Constant	i_Y	1.84	.26	< .001	i_M	4.73	.09	< .001	i_Y	-.18	1.03	.86
			$R^2 = .005$				$R^2 = .053$				$R^2 = .025$		
			$F(2, 187) = .42, p = .66$				$F(2, 188) = 5.27, p = .006$				$F(3, 187) = 1.62, p = .19$		

Table 24

Regression Coefficients, Standard Errors, and Model Summary Information for Mediation of Condition on Percentage of Calories Consumed from Fat by Psychological Variables

			Consequent									
			Y (%Cal_Fat)				*M*				*Y* (%Cal_Fat)	
Psychological Variable	Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Health Self-Efficacy (HSE)	D_1	c_1	-2.29	1.62	.16	a_1	3.87	2.59	.14	c'_1	-2.32	1.64	.16
	D_2	c_2	-.34	1.75	.85	a_2	10.14	2.80	< .001	c'_2	-.43	1.82	.81
	M (HSE)		____	____	____		____	____	____	*b*	.01	.05	.85
	Constant	i_Y	34.81	1.07	< .001	i_M	107.60	1.71	< .001	i_Y	33.89	5.04	< .001
			R^2 = .011				R^2 = .065				R^2 = .01		
			$F(2, 188) = 1.08, p = .34$				$F(2, 188) = 6.56, p = .002$				$F(3, 187) = .73, p = .54$		
Physical Activity Self-Efficacy (PASE)	D_1	c_1	-2.29	1.62	.16	a_1	.17	.14	.24	c'_1	-2.21	1.63	.18
	D_2	c_2	-.34	1.75	.85	a_2	.41	.15	.01	c'_2	-.14	1.79	.94
	M (PASE)		____	____	____		____	____	____	*b*	-.49	.83	.56
	Constant	i_Y	34.81	1.07	< .001	i_M	2.83	.09	< .001	i_Y	36.19	2.58	< .001
			R^2 = .011				R^2 = .037				R^2 = .013		
			$F(2, 188) = 1.08, p = .34$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = .83, p = .48$		
Instrumental Health Attitudes (HAtt_Instr)	D_1	c_1	-2.29	1.62	.16	a_1	.18	.12	.13	c'_1	-2.17	1.63	.19
	D_2	c_2	-.34	1.75	.85	a_2	.14	.13	.28	c'_2	-.25	1.76	.89
	M (HAtt_Instr)		____	____	____		____	____	____	*b*	-.64	1.01	.53
	Constant	i_Y	34.81	1.07	< .001	i_M	6.24	.08	< .001	i_Y	38.80	6.38	< .001
			R^2 = .011				R^2 = .014				R^2 = .014		
			$F(2, 188) = 1.08, p = .34$				$F(2, 188) = 1.31, p = .27$				$F(3, 187) = .85, p = .47$		
	D_1	c_1	-1.71	1.63	.29	a_1	.21	.17	.22	c'_1	-1.58	1.64	.34

	D_2	c_2	-.25	1.74	.88	a_2	.48	.19	.01	c'_2	.04	1.77	.98
Affective Health Attitudes (HAtt_Aff)	M (HAtt_Aff)		____	____	____		____	____	____	b	-.62	.69	.37
	Constant	i_Y	34.72	1.07	< .001	i_M	5.06	.11	< .001	i_Y	37.86	3.64	< .001
			R^2 = .006				R^2 = .035				R^2 = .011		
			$F(2, 185) = .60, p = .55$				$F(2, 185) = 3.33, p = .04$				$F(3, 184) = .67, p = .57$		
	D_1	c_1	-2.29	1.62	.16	a_1	.23	.22	.29	c'_1	-2.29	1.63	.16
	D_2	c_2	-.34	1.75	.85	a_2	.38	.24	.11	c'_2	-.33	1.77	.85
Health Identity (HID)	M (HID)		____	____	____		____	____	____	b	-.02	.54	.98
	Constant	i_Y	34.81	1.07	< .001	i_M	5.32	.14	< .001	i_Y	34.89	3.07	< .001
			R^2 = .011				R^2 = .015				R^2 = .011		
			$F(2, 188) = 1.08, p = .34$				$F(2, 188) = 1.41, p = .25$				$F(3, 187) = .72, p = .54$		
	D_1	c_1	-2.29	1.62	.16	a_1	..48	.20	.02	c'_1	-2.30	1.65	.17
	D_2	c_2	-.34	1.75	.85	a_2	.46	.22	.04	c'_2	.35	1.78	.85
Health Goal Commitment (Commit)	M (Commit)		____	____	____		____	____	____	b	.02	.59	.98
	Constant	i_Y	34.81	1.07	< .001	i_M	4.98	.13	< .001	i_Y	34.74	3.10	< .001
			R^2 = .011				R^2 = .037				R^2 = .011		
			$F(2, 188) = 1.08, p = .34$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = .72, p = .54$		
	D_1	c_1	-2.18	1.63	.18	a_1	.35	.19	.06	c'_1	-2.07	1.65	.21
	D_2	c_2	-.34	1.75	.85	a_2	.20	.20	.32	c'_2	-.27	1.76	.88
Health Goal Progress (Prog)	M (Prog)		____	____	____		____	____	____	b	-.33	.64	.61
	Constant	i_Y	34.81	1.07	<.001	i_M	4.57	.12	< .001	i_Y	36.31	3.12	< .001
			R^2 = .010				R^2 = .019				R^2 = .012		
			$F(2, 187) = .97, p = .38$				$F(2, 187) = 1.84, p = .16$				$F(3, 186) = .73, p = .54$		
	D_1	c_1	-2.29	1.62	.16	a_1	.20	.14	.15	c'_1	-2.39	1.63	.14
	D_2	c_2	-.34	1.75	.85	a_2	.48	.15	.001	c'_2	-.59	1.80	.74
Self-Control Resources (SCR)	M (SSC)		____	____	____		____	____	____	b	.51	.86	.55
	Constant	i_Y	34.81	1.07	< .001	i_M	4.73	.09	< .001	i_Y	32.38	4.20	< .001

	$R^2 = .011$ $F(2, 188) = 1.08, p = .34$	$R^2 = .05$ $F(2, 188) = 5.27, p = .006$	$R^2 = .013$ $F(3, 187) = .84, p = .48$

Note: %Cal_Fat = percentage of calories consumed from fat.

Table 25

Regression Coefficients, Standard Errors, and Model Summary Information for Mediation of Condition on Percentage of Calories Consumed from Sugar by Psychological Variables

			Consequent									
			Y (%Cal_Sugar)				*M*				*Y* (%Cal_Sugar)	
Psychological Variable	Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Health Self-Efficacy (HSE)	D_1	c_1	-1.22	1.57	.44	a_1	3.87	2.59	.14	c'_1	-1.38	1.57	.38
	D_2	c_2	.95	1.69	.58	a_2	10.14	2.80	< .001	c'_2	.51	1.75	.77
	M (HSE)		____	____	____		____	____	____	*b*	.04	.04	.32
	Constant	i_Y	15.42	1.03	< .001	i_M	107.60	1.71	< .001	i_Y	10.71	4.86	.03
			R^2 = .008				R^2 = .065				R^2 = .013		
			$F(2, 188) = .75, p = .47$				$F(2, 188) = 6.56, p = .002$				$F(3, 187) = .83, p = .48$		
Physical Activity Self-Efficacy (PASE)	D_1	c_1	-1.22	1.57	.44	a_1	.17	.14	.24	c'_1	-1.19	1.58	.45
	D_2	c_2	.95	1.69	.58	a_2	.41	.15	.008	c'_2	1.00	1.73	.56
	M (PASE)		____	____	____		____	____	____	*b*	-.13	.80	.87
	Constant	i_Y	15.42	1.03	< .001	i_M	2.83	.09	< .001	i_Y	15.79	2.50	< .001
			R^2 = .008				R^2 = .037				R^2 = .008		
			$F(2, 188) = .75, p = .47$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = .51, p = .68$		
Instrumental Health Attitudes (HAtt_Instr)	D_1	c_1	-1.22	1.57	.44	a_1	.18	.12	.13	c'_1	-1.24	1.58	.43
	D_2	c_2	.95	1.69	.58	a_2	.14	.13	.28	c'_2	.93	1.70	.59
	M (HAtt_Instr)		____	____	____		____	____	____	*b*	.13	.98	.89
	Constant	i_Y	15.42	1.03	< .001	i_M	6.24	.08	< .001	i_Y	14.61	6.18	.02
			R^2 = .008				R^2 = .014				R^2 = .008		
			$F(2, 188) = .75, p = .47$				$F(2, 188) = 1.31, p = .27$				$F(3, 187) = .51, p = .68$		
	D_1	c_1	-1.72	1.57	.27	a_1	.21	.17	.22	c'_1	-1.48	1.57	.34

	D_2	c_2	.91	1.67	.59	a_2	.48	.19	.01	c'_2	1.44	1.70	.40
Affective Health Attitudes (HAtt_Aff)	M (HAtt_Aff)		____	____	____		____	____	____	b	-1.10	.66	.10
	Constant	i_Y	15.45	1.03	< .001	i_M	5.06	.11	< .001	i_Y	21.03	3.48	< .001
			R^2 = .013				R^2 = .035				R^2 = .027		
			$F(2, 185) = 1.18, p = .31$				$F(2, 185) = 3.33, p = .04$				$F(3, 184) = 1.73, p = .16$		
	D_1	c_1	-1.22	1.57	.44	a_1	.23	.22	.29	c'_1	-.94	1.55	.55
	D_2	c_2	.95	1.69	.58	a_2	.38	.24	.11	c'_2	1.41	1.68	.40
Health Identity (HID)	M (HID)		____	____	____		____	____	____	b	-1.21	.52	.02
	Constant	i_Y	15.42	1.03	< .001	i_M	5.32	.14	< .001	i_Y	21.85	2.92	< .001
			R^2 = .008				R^2 = .015				R^2 = .036		
			$F(2, 188) = .75, p = .47$				$F(2, 188) = 1.41, p = .25$				$F(3, 187) = 2.35, p = .07$		
	D_1	c_1	-1.22	1.57	.44	a_1	.48	.20	.02	c'_1	-.80	1.59	.61
	D_2	c_2	.95	1.69	.58	a_2	.46	.22	.04	c'_2	1.35	1.71	.43
Health Goal Commitment (Commit)	M (Commit)		____	____	____		____	____	____	b	-.87	.56	.12
	Constant	i_Y	15.42	1.03	< .001	i_M	4.98	.13	< .001	i_Y	19.75	2.98	< .001
			R^2 = .008				R^2 = .037				R^2 = .021		
			$F(2, 188) = .75, p = .47$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = 1.31, p = .27$		
	D_1	c_1	-1.08	1.58	.49	a_1	.35	.19	.06	c'_1	-.85	1.59	.59
	D_2	c_2	.95	1.69	.58	a_2	.20	.20	.32	c'_2	1.08	1.70	.53
Health Goal Progress (Prog)	M (Prog)		____	____	____		____	____	____	b	-.65	.62	.30
	Constant	i_Y	15.42	1.03	<.001	i_M	4.57	.12	< .001	i_Y	18.37	3.01	< .001
			R^2 = .007				R^2 = .019				R^2 = .013		
			$F(2, 187) = .65, p = .52$				$F(2, 187) = 1.84, p = .16$				$F(3, 186) = .80, p = .50$		
	D_1	c_1	-1.22	1.57	.44	a_1	.20	.14	.15	c'_1	-.88	1.56	.57
	D_2	c_2	.95	1.69	.58	a_2	.48	.15	.001	c'_2	1.75	1.73	.31
Self-Control Resources (SCR)	M (SSC)		____	____	____		____	____	____	b	-1.67	.82	.04
	Constant	i_Y	15.42	1.03	< .001	i_M	4.73	.09	< .001	i_Y	23.29	4.03	< .001

	$R^2 = .008$ $F(2, 188) = .75, p = .47$	$R^2 = .053$ $F(2, 188) = 5.27, p = .006$	$R^2 = .029$ $F(3, 187) = 1.88, p = .14$

Note: %Cal_Sugar = percentage of calories consumed from sugar.

Table 26

Regression Coefficients, Standard Errors, and Model Summary Information for Mediation of Condition on Number of Indulgent Foods Consumed by Psychological Variables

			Consequent									
			Y (#INDULG)				*M*				*Y* (#INDULG)	
Psychological Variable	Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Health Self-Efficacy (HSE)	D_1	c_1	.16	.20	.42	a_1	3.87	2.59	.14	c'_1	.15	.20	.45
	D_2	c_2	-.06	.21	.78	a_2	10.14	2.80	< .001	c'_2	-.08	.22	.73
	M (HSE)		____	____	____		____	____	____	*b*	.00	.01	.75
	Constant	i_Y	1.31	.13	< .001	i_M	107.60	1.71	< .001	i_Y	1.12	.62	.07
			R^2 = .006				R^2 = .065				R^2 = .006		
			$F(2, 188) = .53, p = .59$				$F(2, 188) = 6.56, p = .002$				$F(3, 187) = .39, p = .76$		
Physical Activity Self-Efficacy (PASE)	D_1	c_1	.16	.20	.42	a_1	.17	.14	.24	c'_1	.17	.20	.40
	D_2	c_2	-.06	.21	.78	a_2	.41	.15	.008	c'_2	-.03	.22	.88
	M (PASE)		____	____	____		____	____	____	*b*	-.06	.10	.54
	Constant	i_Y	1.31	.13	< .001	i_M	2.83	.09	< .001	i_Y	1.48	.32	< .001
			R^2 = .006				R^2 = .037				R^2 = .008		
			$F(2, 188) = .53, p = .59$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = .48, p = .70$		
Instrumental Health Attitudes (HAtt_Instr)	D_1	c_1	.16	.20	.42	a_1	.18	.12	.13	c'_1	.16	.20	.43
	D_2	c_2	-.06	.21	.78	a_2	.14	.13	.28	c'_2	-.06	.22	.78
	M (HAtt_Instr)		____	____	____		____	____	____	*b*	.01	.12	.95
	Constant	i_Y	1.31	.13	< .001	i_M	6.24	.08	< .001	i_Y	1.26	.78	.11
			R^2 = .006				R^2 = .014				R^2 = .006		
			$F(2, 188) = .53, p = .59$				$F(2, 188) = 1.31, p = .27$				$F(3, 187) = .36, p = .79$		
	D_1	c_1	.18	.20	.38	a_1	.21	.17	.22	c'_1	.23	.20	.24

	D_2	c_2	-.08	.21	.73	a_2	.48	.19	.01	c'_2	.05	.21	.80
	M		____	____	____		____	____	____	b	-.27	.08	.001
Affective Health Attitudes (HAtt_Aff)	(HAtt_Aff) Constant	i_Y	1.33	.13	< .001	i_M	5.06	.11	< .001	i_Y	2.69	.44	< .001
			R^2 = .007				R^2 = .035				R^2 = .06		
			$F(2, 185) = 67, p = .51$				$F(2, 185) = 3.33, p = .04$				$F(3, 184) = 4.04, p = .008$		
	D_1	c_1	.16	.20	.42	a_1	.23	.22	.29	c'_1	.19	.20	.33
	D_2	c_2	-.06	.21	.78	a_2	.38	.24	.11	c'_2	.00	.21	.98
Health Identity (HID)	M (HID)		____	____	____		____	____	____	b	-.14	.07	.03
	Constant	i_Y	1.31	.13	< .001	i_M	5.32	.14	< .001	i_Y	2.06	.37	< .001
			R^2 = .006				R^2 = .015				R^2 = .03		
			$F(2, 188) = .53, p = .59$				$F(2, 188) = 1.41, p = .25$				$F(3, 187) = 1.92, p = .13$		
	D_1	c_1	.16	.20	.42	a_1	.48	.20	.02	c'_1	.22	.20	.27
	D_2	c_2	-.06	.21	.78	a_2	.46	.22	.04	c'_2	.00	.20	.27
Health Goal Commitment (Commit)	M (Commit)		____	____	____		____	____	____	b	-.13	.07	.06
	Constant	i_Y	1.31	.13	< .001	i_M	4.98	.13	< .001	i_Y	1.96	.38	< .001
			R^2 = .006				R^2 = .037				R^2 = .02		
			$F(2, 188) = .53, p = .59$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = 1.51, p = .21$		
	D_1	c_1	.18	.20	.36	a_1	.35	.19	.06	c'_1	.23	.20	.25
	D_2	c_2	-.06	.21	.78	a_2	.20	.20	.32	c'_2	-.03	.21	.89
Health Goal Progress (Prog)	M (Prog)		____	____	____		____	____	____	b	-.14	.08	.08
	Constant	i_Y	1.31	.13	< .001	i_M	4.57	.12	< .001	i_Y	1.94	.38	< .001
			R^2 = .007				R^2 = .019				R^2 = .024		
			$F(2, 187) = .67, p = .51$				$F(2, 187) = 1.84, p = .16$				$F(3, 186) = 1.51, p = .21$		
	D_1	c_1	.16	.20	.42	a_1	.20	.14	.15	c'_1	.22	.20	.26
	D_2	c_2	-.06	.21	.78	a_2	.48	.15	.001	c'_2	.09	.22	.67

Self-Control Resources (SCR)	*M* (SSC) Constant	i_Y	1.31	.13	< .001	i_M	4.73	.09	< .001	i_Y	2.79	.50	< .001
			$R^2 = .006$ $F(2, 188) = .53, p = .59$				$R^2 = .053$ $F(2, 188) = 5.27, p = .006$				$R^2 = .053$ $F(3, 187) = 3.49, p = .02$		

Note: #INDULG = number of indulgent foods consumed.

Table 27

Regression Coefficients, Standard Errors, and Model Summary Information for Mediation of Condition on Number of Self-Licensed Foods Consumed by Psychological Variables

			Consequent									
			Y (#LICENSED)				*M*				*Y* (#LICENSED)	
Psychological Variable	Antecedent		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*		Coeff.	*SE*	*p*
Health Self-Efficacy (HSE)	D_1	c_1	.06	.09	.52	a_1	3.87	2.59	.14	c'_1	.05	.09	.56
	D_2	c_2	.07	.10	.46	a_2	10.14	2.80	< .001	c'_2	.06	.10	.55
	M (HSE)		____	____	____		____	____	____	*b*	.001	.003	.62
	Constant	i_Y	.14	.06	.03	i_M	107.60	1.71	< .001	i_Y	.001	.28	> .99
			R^2 = .004				R^2 = .065				R^2 = .005		
			$F(2, 188) = .35, p = .70$				$F(2, 188) = 6.56, p = .002$				$F(2, 188) = 6.56, p = .002$		
Physical Activity Self-Efficacy (PASE)	D_1	c_1	.06	.09	.52	a_1	.17	.14	.24	c'_1	.07	.09	.45
	D_2	c_2	.07	.10	.46	a_2	.41	.15	.01	c'_2	.10	.10	.98
	M (PASE)		____	____	____		____	____	____	*b*	-.06	.05	.21
	Constant	i_Y	.14	.06	.03	i_M	2.83	.09	< .001	i_Y	.30	.14	.04
			R^2 = .004				R^2 = .037				R^2 = .012		
			$F(2, 188) = .35, p = .70$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = .76, p = .52$		
Instrumental Health Attitudes (HAtt_Instr)	D_1	c_1	.06	.09	.52	a_1	.18	.12	.13	c'_1	.06	.09	.61
	D_2	c_2	.07	.10	.46	a_2	.14	.13	.28	c'_2	.07	.10	.47
	M (HAtt_Instr)		____	____	____		____	____	____	*b*	.01	.06	.80
	Constant	i_Y	.14	.06	.03	i_M	6.24	.08	< .001	i_Y	.05	.35	.89
			R^2 = .004				R^2 = .014				R^2 = .004		
			$F(2, 188) = .35, p = .70$				$F(2, 188) = 1.31, p = .27$				$F(3, 187) = .25, p = .86$		
	D_1	c_1	.05	.09	.61	a_1	.21	.17	.22	c'_1	.05	.09	.55

	D_2	c_2	.07	.10	.47	a_2	.48	.19	.01	c'_2	.09	.10	.36
Affective Health Attitudes (HAtt_Aff)	M (HAtt_Aff)		____	____	____		____	____	____	b	-.04	.04	.27
	Constant	i_Y	.14	.06	.02	i_M	5.06	.11	< .001	i_Y	.35	.20	.09
			$R^2 = .003$				$R^2 = .035$				$R^2 = .010$		
			$F(2, 185) = .29, p = .75$				$F(2, 185) = 3.33, p = .04$				$F(3, 184) = .60, p = .62$		
	D_1	c_1	.06	.09	.52	a_1	.23	.22	.29	c'_1	.07	.09	.46
	D_2	c_2	.07	.10	.45	a_2	.38	.24	.11	c'_2	.09	.10	.37
Health Identity (HID)	M (HID)		____	____	____		____	____	____	b	-.04	.03	.20
	Constant	i_Y	.14	.06	.02	i_M	5.32	.14	< .001	i_Y	.34	.17	.05
			$R^2 = .004$				$R^2 = .015$				$R^2 = .012$		
			$F(2, 188) = .35, p = .70$				$F(2, 188) = 1.41, p = .25$				$F(3, 187) = .78, p = .51$		
	D_1	c_1	.06	.09	.52	a_1	.48	.20	.02	c'_1	.09	.09	.34
	D_2	c_2	.07	.10	.45	a_2	.46	.22	.04	c'_2	.10	.10	.30
Health Goal Commitment (Commit)	M (Commit)		____	____	____		____	____	____	b	-.06	.03	.06
	Constant	i_Y	.14	.06	.02	i_M	4.98	.13	< .001	i_Y	.44	.17	.01
			$R^2 = .004$				$R^2 = .037$				$R^2 = .023$		
			$F(2, 188) = .35, p = .70$				$F(2, 188) = 3.58, p = .03$				$F(3, 187) = 1.44, p = .23$		
	D_1	c_1	.06	.09	.50	a_1	.35	.19	.06	c'_1	.06	.09	.49
	D_2	c_2	.07	.10	.46	a_2	.20	.20	.32	c'_2	.07	.10	.45
Health Goal Progress (Prog)	M (Prog)		____	____	____		____	____	____	b	-.01	.04	.82
	Constant	i_Y	.14	.06	.02	i_M	4.57	.12	< .001	i_Y	.17	.17	.32
			$R^2 = .004$				$R^2 = .019$				$R^2 = .004$		
			$F(2, 187) = .35, p = .70$				$F(2, 187) = 1.84$, $p = .16$				$F(3, 186) = .26, p = .86$		
Self-Control Resources (SCR)	D_1	c_1	.06	.09	.52	a_1	.20	.14	.15	c'_1	.06	.09	.48
	D_2	c_2	.07	.10	.45	a_2	.48	.15	.001	c'_2	.09	.10	.37
	M (SSC)		____	____	____		____	____	____	b	-.03	.05	.47

Constant	i_Y	.14	.06	.02	i_M	4.73	.09	< .001	i_Y	.30	.23	.20
		$R^2 = .004$				$R^2 = .053$				$R^2 = .007$		
		$F(2, 188) = .35, p = .70$				$F(2, 188) = 5.27, p = .006$				$F(3, 187) = .41, p = .75$		

Note: #LICENSED = number of self-licensed foods consumed.

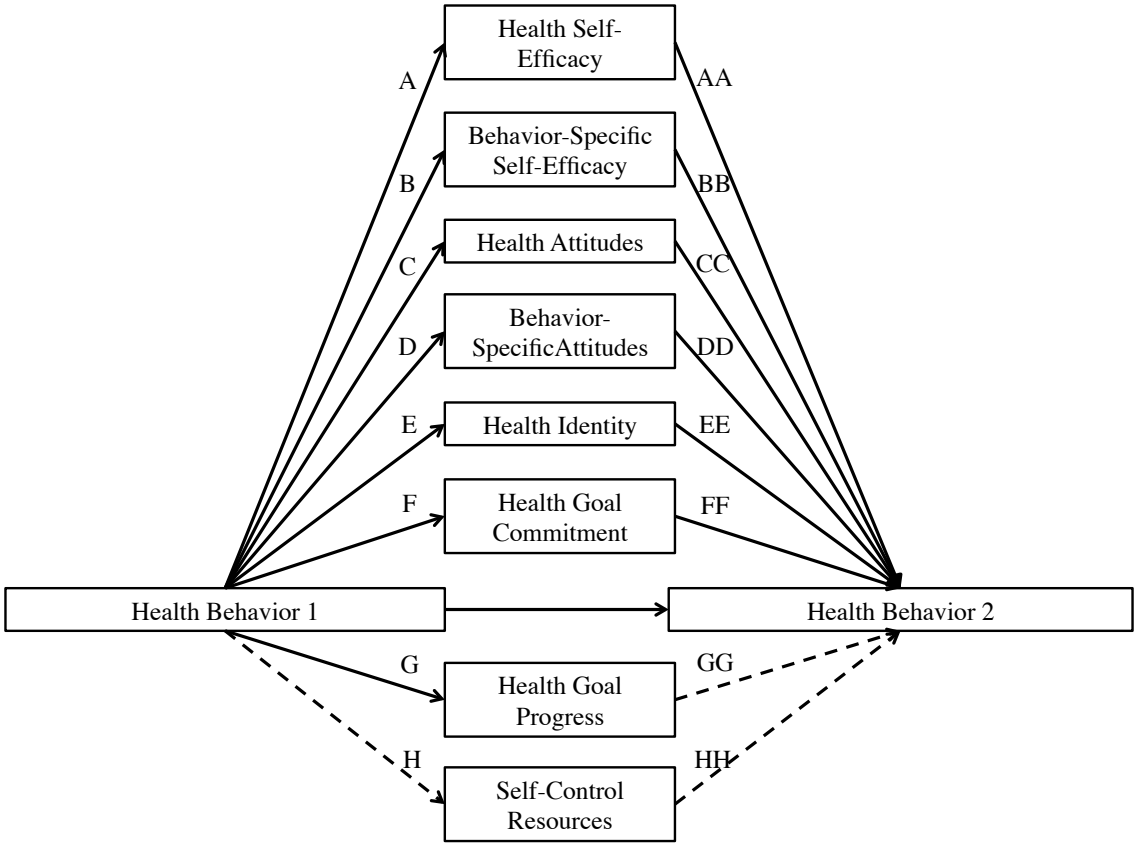

Figure 1. Model depicting the six pathways by which the performance of one health behavior may influence the performance of a second health behavior: self-efficacy (health and physical activity), attitudes (health and physical activity), health identity, health goal commitment, health goal progress, and self-control resources. Dark lines indicate a positive relation, and dashed lines indicate a negative relation.

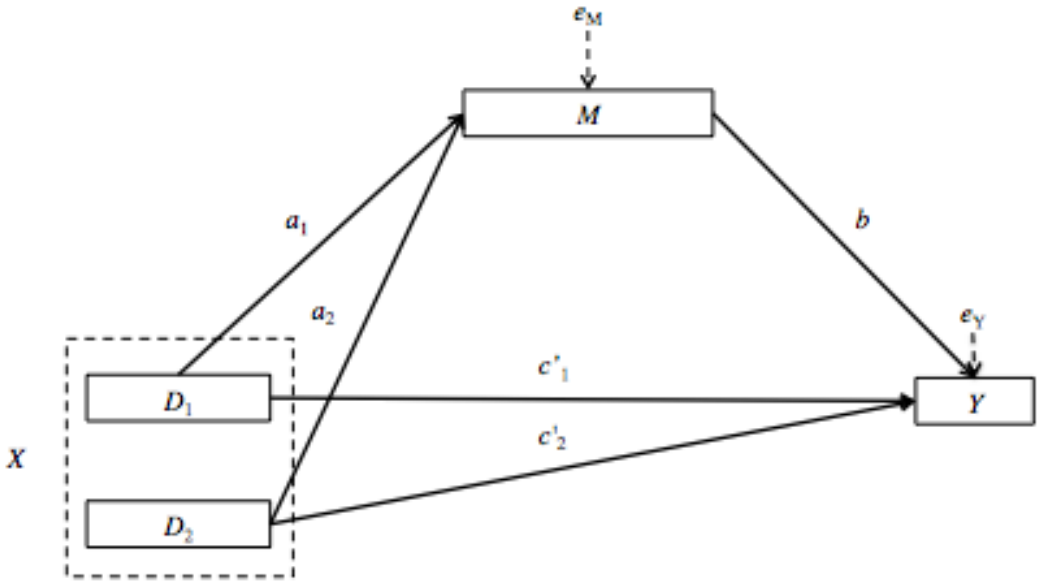

Figure 2. A diagram of the full mediation model that was tested in which D_1 represents participants in the promotion condition, D_2 represents participants in the permitting condition, *M* stands for each of the psychological variables, and *Y* indicates each of the eating behavior outcomes.

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Appendix A: Study 1 Screening Questionnaire

Each question will be asked to potential participants through an online questionnaire that is accessible through the University of Minnesota's Research Experience Program (REP).

1. Are you over the age of 18?
    a. Yes
    b. No
2. Are you willing to complete an exercise session *of your choosing* as part of your participation in this experiment?
    a. Yes
    b. No
3. If "Yes" to 2… Will this exercise session consist of at least 30 minutes of moderate-intensity activity or at least 25 minutes of vigorous-intensity activity?
    a. Yes
    b. No
4. Are you willing to complete two questionnaires: one before and one after you exercise? Each will take approximately 20 minutes.
    a. Yes
    b. No

Appendix B: Study 1 Pre- and Post-Exercise Questionnaire & Study 2 Post-Exercise Questionnaire – Psychological Construct Measures

Instructions: You will be asked to complete a number of measures pertaining to your beliefs and attitudes. Please answer all of the questions honestly. You may leave blank any questions that you do not wish to answer.

The following scale asks whether you are able to perform various health practices within the context of your lifestyle and any disabilities you may have.

Read each statement and use the following scale to indicate how well you are able to do each of the health practices, **not** how often you actually do it.

0 = Not at All
1 = A Little
2 = Somewhat
3 = Mostly
4 = Completely

1. Find healthy foods that are within my budget.
2. Eat a balanced diet.
3. Figure out how much I should weigh to be healthy.
4. Brush my teeth regularly.
5. Tell which foods are high in fiber content.
6. Figure out from labels what foods are good for me.
7. Drink as much water as I need to drink every day.
8. Figure out things I can do to help me relax.
9. Keep myself from feeling lonely.
10. Do things that make me feel good about myself.
11. Avoid being bored.
12. Talk to friends and family about the things that are bothering me.
13. Figure out how I respond to stress.
14. Change things in my life to reduce my stress.
15. Do exercises that are good for me.
16. Fit exercise into my regular routine.
17. Find ways to exercise that I enjoy.
18. Find accessible places for me to exercise in the community.
19. Know when to quit exercising.
20. Do stretching exercises.
21. Keep from getting hurt when I exercise.
22. Figure out where to get information to take care of my health.
23. Watch for negative changes in my body's condition (pressure sores, breathing problems).
24. Recognize what symptoms should be reported to a doctor or nurse.

25. Use medication correctly.
26. Find a doctor or nurse who gives me good advice about how to stay healthy.
27. Know my rights and stand up for myself effectively.
28. Get help from others when I need it.

Physical activity or exercise includes activities such as walking briskly, jogging, bicycling, swimming, and any other activity in which the exertion is at least as intense as these activities.

Circle the number that indicates how confident you are that you could be physically active in each of the following situations.

1 = Not at All Confident
2 = Slightly Confident
3 = Moderately Confident
4 = Very Confident
5 = Extremely Confident

1. When I am tired
2. When I am in a bad mood
3. When I feel I don't have time
4. When I am on vacation
5. When it is raining or snowing

For me, performing **generally recommended health practices** (e.g., refraining from smoking cigarettes, consuming 5 servings of fruits and vegetables daily, exercising for at least 150 minutes per week, etc.) over the next two weeks would be…

Extremely Useful	Quite Useful	Slightly Useful	Neutral	Slightly Useless	Quite Useless	Extremely Useless
1	2	3	4	5	6	7
Wise						Unwise
1	2	3	4	5	6	7
Beneficial						Harmful
1	2	3	4	5	6	7
Enjoyable						Unenjoyable
1	2	3	4	5	6	7
Pleasant						Unpleasant
1	2	3	4	5	6	7
Exciting						Boring
1	2	3	4	5	6	7

For me, **regular physical activity** over the next two weeks would be…

Useful						Useless
1	2	3	4	5	6	7
Wise						Unwise
1	2	3	4	5	6	7
Beneficial						Harmful
1	2	3	4	5	6	7
Enjoyable						Unenjoyable
1	2	3	4	5	6	7
Pleasant						Unpleasant
1	2	3	4	5	6	7
Exciting						Boring
1	2	3	4	5	6	7

Please read the following statements and indicate the extent to which you agree with each *right now, that is, at the present moment* using the following scale.

1 = Completely Disagree
2 = Disagree
3 = Somewhat Disagree
4 = Neither Agree nor Disagree
5 = Somewhat Agree
6 = Agree
7 = Completely Agree

1. Acting healthy is an important part of who I am.
2. I am the type of person who does healthy behaviors.
3. I see myself as a healthy person.

Please indicate the level of commitment that you feel towards reaching your health goals *right now, that is, at the present moment*.

Not at All Committed 1	Low Commitment 2	Slightly Committed 3	Neutral 4	Moderately Committed 5	Very Committed 6	Extremely Committed 7

Please up to list 3 goals that you have related to health.

1. _____
2. _____
3. _____

For each of the three goals, please think about your experience in the recent past and indicate the extent to which you agree with each of the following statements using the following scale.

1 = Completely Disagree
2 = Disagree
3 = Somewhat Disagree
4 = Neither Agree nor Disagree
5 = Somewhat Agree
6 = Agree
7 = Completely Agree

1. I have made a great deal of progress concerning this goal.
2. I have hardly made any progress in the attempt of advancing this goal.

Please indicate the extent to which you agree with each of the following statements using the following scale.

1 = Completely Disagree
2 = Disagree
3 = Somewhat Disagree
4 = Neither Agree nor Disagree
5 = Somewhat Agree
6 = Agree
7 = Completely Agree

1. I need something pleasant to make me feel better.
2. I feel drained.
3. If I were tempted by something right now, it would be very difficult to resist.
4. I would want to quit any difficult task I was given.
5. I feel calm and rational.
6. I can't absorb any information.
7. I feel lazy.
8. I feel sharp and focused.
9. I want to give up.
10. I feel like my willpower is gone.
11. I am having a hard time controlling my urges.

Appendix C: Study 1 Pre-Exercise Questionnaire – Demographic Questions

We would like you to give us a little information about yourself. Before completing this questionnaire, please respond to the following background questions.

1. What is your age? _____

2. Your gender? _____

3. Please indicate your race/ethnicity. Check all that apply.

    a. Latino/Hispanic
    b. Black/African American/African
    c. Asian/Asian American
    d. White/Caucasian
    e. Native American
    f. Other _____

4. What is your height (in inches)?
5. What is your weight (in pounds)?

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time.

This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**
_____ **minutes per day**

☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

Appendix D: Study 1 Post-Exercise Questionnaire
(included all of the psychological construct measures from Appendix B in addition to the following questions)

Please tell us about the exercise session that you just completed.

1. What kind(s) of exercise did you do (e.g., ran on treadmill, lifted weights)?
   _____
   a. How long did you do each kind(s) of exercise (in minutes)?
      _____
2. How intense would you rate your entire overall exercise session, where 1 = "not at all intense" and 10 = "extremely intense"? _____

Appendix E: Study 2 Screening Questionnaire

Thank you for your interest in our study. In the study, you may be asked to perform a certain task in the laboratory. Please indicate with a check mark which of the following tasks you would be comfortable doing in a laboratory environment.

___ Participate in a social interaction task with strangers
___ Be exposed to a moderately physically painful stimuli
___ Drink alcohol
___ Complete a 30-minute moderate-intensity exercise session
___ Sample vegan food items
___ Participate in a meditation session

Are you over the age of 18?

a. Yes
b. No

Did you participate in "The Lifestyle Behavior Study – Part 1" or "The Lifestyle Behavior Study – Part 2, Piloting?"

a. Yes
b. No

Appendix F: Four-Dimension Mood Scale

This scale consists of a number of words that describe different feelings and emotions. Read each item and then list the number from the scale below next to each word. **Indicate the extent you feel this way right now, that is, at the present minute.**

1 = Very slightly or not at all
2 = Slightly
3 = Moderately
4 = Very
5 = Extremely

1. Active ____
2. Calm ____
3. Aggravated ____
4. Exhausted ____
5. Energetic ____
6. Peaceful ____
7. Agitated ____
8. Fatigued ____
9. Lively ____
10. Relaxed ____
11. Hostile ____
12. Tired ____
13. Vigorous ____
14. Serene ____
15. Irritable ____
16. Weary ____
17. Tranquil ____
18. Upset ____
19. Worn Out ____
20. Uptight ____

Appendix G: Servings of Fruits and Vegetables

Food	Serving Size	Number of Calories
Apple	1 small apple	77
Applesauce (unsweetened)	½ cup	50
Artichoke	1 artichoke	25
Asparagus	4 large spears	13
Avocado	1/3 avocado	78
Baby carrots	1 cup or 12 baby carrots	42
Banana	1 large banana	105
Black beans	½ cup	90
Black olives	1 cup	240
Broccoli (raw or cooked)	1 cup	240
Cantaloupe	1 cup	60
Cauliflower	1 cup	28
Cauliflower rice	1 cup	37
Carrots	1 medium	25
Celery	2 stalks	14
Chickpeas	½ cup	143
Clementine	2 small fruit	70
Corn kernels	1 cup	125
Corn on the cob	½ of a whole corn	40
Eggplant	1 cup	35
Fruit cup	1 serving	80
Fruit (dried)	½ cup	Varies
Fruit juice	Up to the first 8 oz	Varies
Grapes	1 cup or 32 grapes	101
Kale	2 cups	66
Kiwi	2 medium kiwis	93
Mixed vegetables	1 cup	50
Peas (cooked)	1 cup	117
Pickle spears	4 spears	17
Pineapple	1 cup	82
Pinto beans	½ cup	144
Potatoes (not fried)	1 cup	110
Raspberries	1 cup or 36 raspberries	60
Red lentils	½ cup	260
Roasted red peppers	½ cup	140
Romaine lettuce	2 cups	12
Salad greens (raw)	2 cups	14
Stir fry vegetables	1 cup	59
Strawberries	1 cup or 8 strawberries	53
Sun-dried tomatoes	½ cup	70

Sweet potato	½ a whole sweet potato	60
Tomatoes	2 small raw tomatoes or 1 cup or 20 cherry tomatoes	30
Veggie burger	1 burger	Varies
Zucchini	1 cup	33

Appendix H: Food Log Questions

1. Please take a moment to review the foods listed in your food diary. Do you consider any of the foods that you consumed today to be an indulgent food?
    a. Yes
    b. No
2. If yes, please list the food(s) that you consider to be indulgent.
    a. _____
    b. _____
    c. _____
    d. _____
3. Please take a moment to again review the foods listed in your food diary. Are there any foods that you ate today that you would **not** have eaten if you had not exercised/watched cartoons yesterday?
    a. Yes
    b. No
4. If yes, please list the food(s) that you would not have eaten if you had not exercised/watched cartoons yesterday.
    a. _____
    b. _____
    c. _____
    d. _____